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PTO/SB/50 (4/98)
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REISSUE PATENT APPLICATION TRANSMITTAL

Address to:
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Box Patent Application
Washington, DC 20231

Attorney Docket No.	FUSA 12.689A
First Named Inventor	Kazuo SAKAGAWA
Original Patent Number	5,774,662
Original Patent Issue Date (Month/Day/Year)	06/30/1998
Express Mail Label No.	EM367156855US

APPLICATION FOR REISSUE OF: *(check applicable box)* [X] *Utility Patent* [ ] *Design Patent* [ ] *Plant Patent*

APPLICATION ELEMENTS

1. [X] * Fee Transmittal Form *(PTO/SB/56)* *(Submit an original, and a duplicate for fee processing)*
2. [X] Specification and Claims (*amended, if appropriate*)
3. [X] Drawing(s) *(proposed amendments, if appropriate)*
4. [X] Reissue Oath / Declaration (original or copy) *(37 C.F.R. § 1.175)(PTO/SB/51 or 52)*
5. Original U.S. Patent
   - [X] Offer to Surrender Original Patent *(37 C.F.R. § 1.178)(PTO/SB/53 or PTO/SB/54)*
   - *or*
   - [ ] Ribboned Original Patent Grant
   - [ ] Affidavit / Declaration of Loss *(PTO/SB/55)*
6. Original U.S. Patent currently assigned?
   - [X] Yes [ ] No

   (If Yes, check applicable box(es))
   - [X] Written Consent of all Assignees *(PTO/SB/53 or 54)*
   - [ ] 37 C.F.R. § 3.73(b) Statement [ ] Power of Attorney

ACCOMPANYING APPLICATION PARTS

7. [ ] Foreign Priority Claim *(35 U.S.C. 119)* *(if applicable)*
8. [X] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
9. [ ] English Translation of Reissue Oath/Declaration *(if applicable)*
10. [ ] * Small Entity Statement(s) *(PTO/SB/09-12)* [ ] Statement filed in prior application, Status still proper and desired
11. [ ] Preliminary Amendment
12. [X] Return Receipt Postcard *(MPEP 503)* *(Should be specifically itemized)*
13. [X] Other: Request for Abstract of Title
    Request for Transfer of Drawings
    Preliminary Remarks
    Request for Drawing Changes; Letter
    Verified Translation of Priority Document

NOTE FOR ITEMS 1 & 10: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

14. CORRESPONDENCE ADDRESS

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NAME (Print/Type)	Samson Helfgott	*Registration No. (Attorney/Agent)*	23,072
Signature	Samson Helfgott	*Date*	10/26/1999

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Filed by Express Mail
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on October 26, 1999
pursuant to 37 C.F.R. 1.10
by Linda S. Chan

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REISSUE APPLICATION FEE TRANSMITTAL FORM

Docket Number (Optional): FUSA 12.689A

Claims as Filed - Part 1

Claims in Patent	For	Number Filed in Reissue Application	(3) Number Extra	Small Entity Rate	Small Entity Fee		Other than a Small Entity Rate	Other than a Small Entity Fee
(A) 20	Total Claims (37 CFR 1.16(j))	(B) 39	**** 19 =	x $___ =		or	x $ 22 =	418
(C) 3	Independent Claims (37 CFR 1.16(i))	(D) 10	* 7 =	x $___ =			x $ 82 =	574
			Basic Fee (37 CFR 1.16(h))		$___			$ 790
			Total Filing Fee		$		OR	$ 1782.00

Claims as Amended - Part 2

	(1) Claims Remaining After Amendment		(2) Highest Number Previously Paid For	(3) Extra Claims Present	Small Entity Rate	Small Entity Fee		Other than a Small Entity Rate	Other than a Small Entity Fee
Total Claims (37 CFR 1.16(j))	***	MINUS	**	* =	x $___ =		or	x $___ =	
Independent Claims (37 CFR 1.16(i))	***	MINUS	*****	=	x $___ =			x $___ =	
				Total Additional Fee		$		OR	$

* If the entry in (D) is less than the entry in (C), Write "0" in column 3.
** If the "Highest Number of Total Claims Previously Paid For" is less than 20, Write "20" in this space.
*** After any cancelation of claims
**** If "A" is greater than 20, use (B -A); if "A" is 20 or less, use (B - 20).
***** "Highest Number of Independent Claims Previously Paid For" or Number of Independent Claims in Patent (C).

☐ Please charge Deposit Account No. _____ in the amount of _____.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any additional fees under 37 CFR 1.16 or 1.17 which may be required, or credit any overpayment to Deposit Account No. 08-1634.
A duplicate copy of this sheet is enclosed.

☒ A check in the amount of $ 1782.00 to cover the filing / additional fee is enclosed.

10/26/1999
Date

Signature of Applicant, Attorney or Agent of Record

Samson Helfgott, Reg. No. 23,072
Typed or printed name

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(Receipt No. EM367156855US
on October 26, 1999
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor:	Kazuo Sakagawa
Serial No.:	08/446,496
Filed:	May 22, 1995
Reissue of Patent No.:	5,774,662
Title:	SYSTEM FOR SERVER OBTAINING TERMINAL ADDRESS VIA SEARCHING ADDRESS TABLE OR VIA BROADCASTING TO ALL TERMINALS THROUGH EXCHANGE IN RESPONSE TO TERMINAL ADDRESS INTERROGATION REQUEST
Issued:	June 30, 1998

Assistant Commissioner For Patents
Washington, D.C. 20231

LETTER

SIR:

The above-identified reissue application for Letters Patent is enclosed herewith for filing in the United States Patent Office within two years of the issue date of the original patent. We enclose the following items:

1. Specification and claims
2. Declaration of Inventor
3. Assent of Assignee to Reissue
4. Offer to Surrender
5. Request for Abstract of Title
6. Request for Transfer of Drawings

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Filed by Express Mail
(Receipt No. EM367156855US
on October 26, 1999
pursuant to 37 C.F.R. 1.10
by

7. Drawings (Eight Sheets)

8. Proposed Drawing Changes

9. Preliminary Remarks

10. IDS

11. Verified English translation of priority document.

Additionally, a check has been enclosed to cover the total filing fee in connection with the reissue application and the fee for requesting the title report.

Any fee due with this paper, not fully covered by an enclosed check, may be charged to Deposit Account 08-1634.

Respectfully submitted,

Samson Helfgott
Reg. No. 23,072

Helfgott & Karas, P.C.
Empire State Building
New York, New York 10118
(212) 643-5000
Docket No: 12.689A

SH/gau/16496

IN THE UNITED PATENT AND TRADEMARK OFFICE

Inventor:	Kazuo Sakagawa
Serial No.:	08/446,496
Filed:	May 22, 1995
Reissue of Patent No.:	5,774,662
Title:	SYSTEM FOR SERVER OBTAINING TERMINAL ADDRESS VIA SEARCHING ADDRESS TABLE OR VIA BROADCASTING TO ALL TERMINALS THROUGH ECHANGE IN RESPONSE TO TERMINAL ADDRESS INTERROGATION REQUEST
Issued:	June 30, 1998

Assistant Commissioner For Patents
Washington, D.C. 20231

ASSENT OF ASSIGNEE TO REISSUE

S I R

Fujitsu Limited, a corporation of Japan having a principal place of business at 1-1 Kamikodanaka, 4-chome, Nakahara-ku, Kawasaki-Shi, Kanagawa, 211 Japan, owner of the undivided and entire interest in and to the subject patent, hereby assents to the filing of the present reissue application.

Filed by Express Mail
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on October 26, 1999
pursuant to 37 C.F.R. 1.10
by [signature]

By: [signature]
Name:
Title:
Date: Oct. 19, 1999

SH/gau/16499

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IN THE UNITED PATENT AND TRADEMARK OFFICE

Inventor:	Kazuo Sakagawa
Serial No.:	08/446,496
Filed:	May 22, 1995
Reissue of Patent No.:	5,774,662
Title:	SYSTEM FOR SERVER OBTAINING TERMINAL ADDRESS VIA SEARCHING ADDRESS TABLE OR VIA BROADCASTING TO ALL TERMINALS THROUGH ECHANGE IN RESPONSE TO TERMINAL ADDRESS INTERROGATION REQUEST
Issued:	June 30, 1998

Assistant Commissioner For Patents
Washington, D.C. 20231

OFFER TO SURRENDER

S I R

The undersigned Applicant of the accompanying Reissue Application of letters patent for U.S. Patent No. 5,774,662 granted to them on June 30, 1998 of which Fujitsu Limited is now the sole owner by assignment and on whose behalf and with whose assent the accompanying application is made hereby offers to surrender said letters patent.

Filed herewith is an assent of assignee to reissue and an order for a Title Report as required in such applications.

Kazuo Sakagawa

Kazuo Sakagawa
SH/gau/16500

October 14, 1999

Date

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IN THE UNITED PATENT AND TRADEMARK OFFICE

Inventor:	Kazuo Sakagawa
Serial No.:	08/446,496
Filed:	May 22, 1995
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Title:	SYSTEM FOR SERVER OBTAINING TERMINAL ADDRESS VIA SEARCHING ADDRESS TABLE OR VIA BROADCASTING TO ALL TERMINALS THROUGH EXCHANGE IN RESPONSE TO TERMINAL ADDRESS INTERROGATION REQUEST
Issued:	June 30, 1998

Assistant Commissioner For Patents
Washington, D.C. 20231

PRELIMINARY REMARKS

S I R

As a result of a recent discussion with the inventor, the inventor indicated that the description relating to the use of a broadcast method of broadcasting an interrogation request to all terminals in an ATM was not known or reduced to practice by others before the priority date of this application, but was in fact his own idea. Japanese inventors sometimes describe their own ideas, which are in fact unknown by others, as prior art for convenience in explaining what they believe is an aspect of the invention. However, in fact, the inventor himself had come up with such broadcast method for ATM.

The specification has therefore been amended on columns 2, 3 and 12 to rearrange the paragraphs relating to this method as part of the new invention rather than part of the background invention. Likewise, Figure 23 is being amended to delete the reference to this figure as prior art.

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Other minor typographical errors are being corrected in the specification on columns 1, 5 and 16 as well as in the drawings Figs. 5, 6, 15, 16 and 21. The specification in column 15 has clarified what is shown in step 407(b).

In the claims, all of the original Claims, 1-15, are retained without change. New Claims 16-39 are submitted. These include the broadcast technique for an ARP request in an ATM system. Most of the language corresponds to some of the language utilized in Claims 1-15.

All additional material has been indicated by the use of underlines. All deleted material has been indicated by the use of brackets. All corrections to the drawings have been noted in red.

These remarks are being submitted to assist the Examiner in further understanding the reasons for the present reissue.

Any fee due with this paper, not fully covered by an enclosed check, may be charged to Deposit Account 08-1634.

Respectfully submitted,

Samson Helfgott
Reg. No. 23,072

Helfgott & Karas, P.C.
Empire State Building
New York, New York 10118
(212) 643-5000
Docket No: 12.689A

SH/gau/16501

SYSTEM FOR SERVER OBTAINING TERMINAL ADDRESS VIA SEARCHING ADDRESS TABLE OR VIA BROADCASTING TO ALL TERMINALS THROUGH EXCHANGE IN RESPONSE TO TERMINAL ADDRESS INTERROGATION REQUEST

BACKGROUND OF THE INVENTION

This invention relates to a communication system such as an ATM-LAN, a server and an address management method. More particularly, the invention relates to a communication system equipped with a plurality of terminals, a server having an ATM address table for storing the corresponding relationship between the protocol address and ATM address of each terminal, and an ATM exchange which accommodates each terminal and the server.

Improvements in the performance of personal computers and work stations have been accompanied by the rapid proliferation of applications for dealing with high-speed data and multimedia. In addition, such techniques as remote file access and decentralized computing have been established though use of LAN[S]. For these reasons, there is expected to be greater demand for higher speed LANs for multimedia purposes.

In order to satisfy these expectations, there has been increased activity in the research and development of LANs (ATM-LANs) using ATM communication. An ATM-LAN is a switching LAN in which terminals are connected in a star-like configuration to an apparatus (an ATM exchange, for example) having an ATM switching function. Each terminal establishes a virtual channel (VC) directed toward a destination terminal and performs a data transmission by means of a fixed-length packet, referred to as an ATM cell, comprising a five-byte header and 48-byte data. As a result, it is possible to set a number of VCs on a terminal interface (where the number is capable of being expressed by the VPI/VCI) so that the terminal is capable of communicating with a plurality of other terminals simultaneously via the set VCs.

When communication is performed on a LAN, it is generally required that the originating terminal know the physical address of the terminal of the other party. In a conventional LAN, the physical address is a MAC address. Data in a LAN is transmitted in frame units, with each frame containing the addresses of the originating and terminating terminals. FIG. 21 is a diagram of a frame in a case where the protocol of a LAN is TCP/IP. The frame includes a start delimiter (SD) and an end delimiter (ED) between which are placed a destination address DA serving as a control field and a layer-2 address (MAC address), a sending address SA, an information field I (IP packet) and a frame scanning sequence FSC. The IP packet is subdivided into a control information field, a destination address DA' serving as a protocol address (IP address), a sending address SA' and an information field I'.

Communication with another terminal is not possible if the MAC address of the terminal is not known. If the MAC address of a party's terminal in unknown (but the protocol address is known), therefore, the original terminal determines the MAC address of the higher-order protocol address (IP address) by an address resolution protocol (ARP) and performs communication upon disassembling the higher-order packet (IP packet) into frames using the MAC address.

FIG. 22 is a processing flowchart of the ARP. If the MAC address of another party's terminal is unknown (NO at step S1), the originating terminal creates a frame (ARP frame)

and sends the frame to the LAN (step S2). The ARP frame contains ① a broadcast address as the destination MAC address DA of the frame, ② a protocol address of another party's terminal serving as the destination protocol address DA', and ③ an indication that the frame is an ARP frame, this serving as control information CF'.

Upon receiving this ARP frame, each terminal determines whether the frame has its own address or is a broadcast frame. In this case, the frame is a broadcast frame and therefore the frame is accepted (step S11). Next, after verification of the fact that the frame is an ARP frame, each terminal determines whether the protocol address of the destination agrees with its own protocol address (step S12). Processing is terminated if the two addresses disagree. If the two addresses do agree, however, an answer frame which contains the terminals own MAC address is created at sent back to the originating terminal (step S13). Upon receiving the answer frame (YES at step S3), the originating terminal registers the correspondence between the MAC address of the other party's terminal contained in this answer frame and the protocol address in an internal IP-MAC address table (step S4) and then creates a frame (see FIG. 21) using the other party's MAC address and sends this frame to the LAN to perform LAN communication (step S5).

The foregoing is for the case of connection-less communication. In an ATM-LAN based upon connection-type communication, a VC is established between terminals and communication is performed while forming a higher-order packet into cells. In such an ATM-LAN, a physical address corresponds to the address (VPI/VCI) of the ATM layer, and this ATM layer address (VPI/VCI) is decided by a set-up sequence using the ATM address of the terminal. A set-up sequence is a call set-up processing sequence executed at the time of an outgoing call.

Thus, when the ATM address of the other party's terminal is unknown in an ATM-LAN, communication cannot be performed. This necessitates a method of analyzing the ATM address based upon the higher-order protocol address.

Conventional methods of acquiring the ATM address of another party's terminal include a broadcast method of broadcasting an interrogation request to all terminals and a server method of providing a server within the ATM-LAN and interrogating the server.

FIG. 23 is a diagram for describing the broadcast method. Terminals 1*a*, 1*b*, 1*c* are connected to an ATM-LAN 2. According to the broadcast method, the ATM address interrogation request is broadcast within the network if the ATM address of the other party's terminal is unknown at the moment a communication request is generated, and a prescribed terminal responds to this interrogation by answering with its own ATM address. For example, if the ATM address of terminal 1*b* is unknown to the terminal 1*a* when this terminal communicates with the terminal 1*b* in FIG. 23, the terminal 1*a* broadcasts an ATM address interrogation request cell (which has the protocol address of terminal 1*b*) within the network. The terminal 1*b*, which is that terminal having a protocol address identical with that contained in the received cell, answers the terminal 1*a* with its own ATM address. The terminal 1*a* uses the received ATM address to call the terminal 1*b* and communicate with it.

FIG. 24 is a diagram for describing the server method. FIG. 24 shows the terminals 1*a*, 1*b*, 1*c* and the ATM-LAN 2, which in this case is provided with a server 3. According to the server method, the corresponding relation between protocol addresses and ATM addresses of all terminals is registered in an ATM address table in advance. If the ATM

address of another party's terminal is unknown at the moment a communication request is issued, an ATM address interrogation request is sent to the server and the server answers by retrieving the ATM address from the ATM address table. For example, if the ATM address of terminal 1*c* is unknown to the terminal 1*a* when this terminal communicates with the terminal 1*c* in FIG. 24, the terminal 1*a* sends the server 3 an ATM address interrogation cell (which has the protocol address of terminal 1*c*). The server 3 answers the terminal 1*a* by retrieving the ATM address of terminal 1c from the ATM address table, and the terminal 1*a* uses the received ATM address to call the terminal 1*c* and communicate with it.

If the ATM address of another party's terminal is unknown at the moment a communication request is issued in the broadcast method, a broadcast is made within the network and the terminal is interrogated directly. Unlike the server method, implementation is easy because it is unnecessary to create a data base in advance. However, in cases where frequent communication is made with an unspecified terminal whose ATM address is unknown, broadcast of the interrogation request is made whenever a communication request is issued. A problem which arises as a consequence is an increase in control traffic. This problem becomes particularly pronounced with an increase in the number of terminals or depending upon the scale of the network.

With the server method, on the other hand, there is no increase in traffic because there is no broadcast of an interrogation request. However, it is required that information (the correlation information between protocol addresses and ATM addresses) regarding all terminals connected to the ATM-LAN be registered in the ATM address table in advance. At the time of initial installation, therefore, it is necessary that the information regarding all terminals be registered in a data base (ATM address table) and that the data base be updated whenever a terminal is added on or moved. Further, an increase in the number of terminals or an increase in the scale of the network necessitates a data base of a larger capacity. This leads to an increase in the scale of the server hardware.

SUMMARY OF THE INVENTION

Accordingly, a first object of the present invention is to provide a communication system such as an ATM-LAN, a server and an address management method whereby the problems of the aforementioned methods are mitigated using the server method and broadcast method in combination.

A second object of the present invention is to provide a communication system such as an ATM-LAN, a server and an address management method in which an increase in traffic can be suppressed.

A third object of the present invention is to provide a communication system such as an ATM-LAN, a server and an address management method in which an initial setting or updating of an address table (data base) is not necessary at the time of initial installation or whenever a terminal is added on or moved.

A fourth object of the present invention is to provide a communication system such as an ATM-LAN, a server and an address management method in which a large-capacity data base is not required, thus making it possible to reduce the scale of server hardware.

In accordance with the present invention, the foregoing objects are attained by providing an address management method comprising a first step in which an originating terminal sends a terminal address interrogation request to a

server if the terminal address of another party's terminal is unknown at the time of communication, a second step in which the server, upon receiving the terminal address interrogation request from the terminal, refers to an address table and searches for a terminal address corresponding to a protocol address contained in the interrogation request, a third step in which, if a terminal address corresponding to the protocol address is obtained from the address table, the server notifies the terminal of this terminal address, a fourth step in which, if the terminal address is not obtained from the address table, the server transfers the terminal address interrogation request containing the protocol address to all terminals via an exchange, a fifth step in which, when each terminal receives the terminal address interrogation request transferred from the server, the terminal determines whether the protocol address contained in the interrogation request agrees with its own protocol address and notifies the server of its own terminal address if agreement is achieved, and a sixth step in which the server notifies the originating terminal of the terminal address of which it has been notified.

Further, according to the present invention, the foregoing objects are attained by providing a communication system equipped with a plurality of terminals, a server having an address table for storing the corresponding relationship between a protocol address and terminal address of each terminal, and an exchange which accommodates each terminal and the server, wherein (1) each terminal includes means for sending a terminal address interrogation request to the server if the terminal address of another party's terminal is unknown at the time of communication, communication means for communicating with the other party's terminal via the exchange using a terminal address of which it has been notified by the server in response to the interrogation request, and terminal address answering means for answering the server with its own terminal address if a protocol address contained in a terminal address interrogation request transferred from the server agrees with its own protocol address, and (2) the server includes means for referring to the address table and searching for a terminal address corresponding to a protocol address contained in a terminal address interrogation request from a terminal, means which, if a terminal address corresponding to the protocol address has not been registered in the address table, is for transferring the terminal address interrogation request containing this protocol address to all terminals via the exchange, and means for notifying the terminal which has issued the interrogation request of a terminal address obtained from the address table or of a terminal address obtained by an answer from a terminal.

Furthermore, in accordance with the present invention, the foregoing objects are attained by providing a server comprising an address table for storing the corresponding relationship between a protocol address and terminal address of each of a plurality of terminals, search means for referring to the address table and searching for a terminal address corresponding to a protocol address contained in a terminal address interrogation request from a terminal, and interrogation means which, if a terminal address corresponding to the protocol address has not been registered in the address table, is for interrogating all terminals, via an exchange, for the terminal address corresponding to this protocol address, wherein in response to receipt of a terminal address interrogation request from an originating terminal, the search means refers to the terminal address table to obtain the terminal address conforming to the protocol address contained in this terminal address interrogation request and, if this terminal address has not been registered, the interrogation means interrogates all the terminal for terminal address.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 a block diagram for describing the principles of the present invention;

FIG. 2 is a diagram showing the configuration of an ATM-LAN according to the present invention;

FIG. 3 is a diagram showing an ATM address table according to the present invention;

FIGS. 4A, 4B are diagrams showing the constitution of an ATM cell;

FIG. 5 is a diagram showing the detailed constitution of an ATM cell to which a tag has been added;

FIG. 6 is a table for describing the relationship between tag information and outgoing lines;

FIG. 7 is a diagram for describing an ATM switch;

FIG. 8 is diagram showing a simplified representation of the ATM switch;

FIG. 9 is a diagram for describing broadcast of an ATM-[ARM] ARP request;

FIG. 10 is a diagram useful in describing control or sending receiving of an ATM-ARP message;

FIG. 11 is a diagram (part 1) for describing a communication sequence according to the present invention;

FIG. 12 is a diagram for describing the format of the ATM-ARP message;

FIG. 13 is a diagram (part 2) for describing the communication sequence according to the present invention;

FIG. 14 is a flowchart of processing executed by an originating terminal when a communication request is issued;

FIG. 15 is a flowchart of processing executed by terminating terminal when an ATM-ARP request is received;

FIG. 16 is a flowchart of processing executed by a server;

FIG. 17 is a flowchart showing ATM-ARP request transfer processing in a case where a terminal has been divided into groups;

FIG. 18 is a block diagram showing the construction of a server;

FIG. 19 is a diagram showing the construction of a terminal;

FIG. 20 is a block diagram showing the construction of a server accommodating section;

FIG. 21 is a diagram showing the constitution of a frame;

FIG. 22 is a flowchart of ARP processing in a LAN according to the prior art;

FIG. 23 is a diagram (according to the broadcast method) for describing conventional ARP processing in an ATM-LAN; and

FIG. 24 is a diagram (according to the server method) for describing conventional ARP processing in an ATM-LAN.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

(A) Overview of the invention

FIG. 1 is a diagram for describing the principles of the present invention.

As shown in FIG. 1, terminals 11, 12, 13, . . . are connected to a server 21. The terminals and the server are accommodated by an ATM exchange 31.

The terminals 11, 12, 13 have respective request generating means 11*a*, 12*a*, 13*a* for sending an ATM address interrogation request to the server 21 if the ATM address of another party's terminal is unknown at the time of communication; answering means 11*b*, 12*b*, 13*b* which communicate with the other party's terminal via the ATM exchange 31 using an ATM address of which it has been noted by the server in response to an ATM address interrogation request; and answering means 11*c*, 12*c*, 13*c* each of which answers the server with its own ATM address if a protocol address contained in an ATM address interrogation request transferred from the server 21 agrees with its own protocol address.

The server 21 includes an ATM address table 21*a* for storing, by use of a learning function, the corresponding relationship between the protocol address and ATM address of each terminal; search means 21*b* for referring to the ATM address table 21*a* and searching for an ATM address corresponding to a protocol address contained in an ATM address interrogation request from a terminal; broadcast means 21*c* which, if an ATM address for which it has been interrogated is not obtained from the ATM address table 21*a*, broadcasts an ATM address interrogation request to all terminals via the ATM exchange 31; and answering means for answering a terminal, which has issued the interrogation request, with the ATM address for which it has been interrogated.

The terminal 11, which is the originating terminal, sends an ATM address interrogation request to the server 21 if the ATM address of another party's terminal (terminal 12) is unknown at the time of communication. Upon receiving the ATM address interrogation request from the terminal 11, the server 21 refers to the ATM address table 21*a* and searches for an ATM address corresponding to the protocol address of the terminal 12 contained in the interrogation request. If an ATM address corresponding to the protocol address has been registered in the ATM address table 21*a*, the server 21 notifies the terminal 11 of this ATM address. If an ATM address corresponding to the protocol address has not been registered in the ATM address table 21*a*, however, the server 21 transfers the ATM address interrogation request containing the above-mentioned protocol address to all terminals 12, 13, . . . via the ATM exchange 31. When each terminal 12, 13, . . . receives the ATM address interrogation request transferred from the server 21, the terminal checks to see whether the protocol address contained in the interrogation request agrees with its own protocol address. Since the protocol address contained in the interrogation request agrees with its own protocol address, the terminal 12 notifies the server 21 of its own ATM address. The server 21 notifies the originating terminal 11 of the ATM address of which it has been notified. As a result, the originating terminal 11 communicates with the other party's terminal 12 via the ATM exchange 31 using the ATM address of which it has been notified by the server 21.

Thus, if an ATM address has been registered in the ATM address table of the server, the ATM address can be obtained through an operation similar to that of the conventional server method in response to the interrogation request for this ATM address. If the ATM address has not been registered in the ATM address table, the interrogation request for this ATM address is broadcast to enable the ATM address to be obtained. In other words, ATM addresses are managed by making joint use of the server method and broadcast method. This makes it possible to suppress an increase in the amount of control traffic. Moreover, ATM addresses can be perfected by successively registering corresponding relationships, which have been found using the broadcast method, in the

ATM address table. In addition, it is possible to dispense with a task for initially setting the ATM address table and a ask for updating the table when terminals are added on or noved.

Furthermore, if all terminals are divided up into a plurality of groups and a desired ATM address has not been registered n the ATM address table, the server transfers the ATM address interrogation request cell to all terminals of the first group. Monitoring is performed to determine whether a prescribed terminal has answered with the ATM address within a set period of time. If notification of the ATM address is not received within the set time period, the server ransfers the interrogation request cell to all terminals of the next group. Thus, the server transfers the interrogation request cell while successively changing groups until the prescribed terminal answers with the ATM address. If this arrangement is adopted, there is a good possibility that the desired ATM address will be obtained before the interrogation request is sent to all terminals. As a result, any increase in traffic can be suppressed.

Further, upon receiving notification of the desired ATM address from the prescribed terminal, the server **21** registers the correspondence between the protocol address of this terminal and the ATM address of which it has been notified in the ATM address table **21***a* anew. Further, the server registers, in the ATM address table **21***a*, the corresponding relationship between the protocol address of the originating terminal, which address is contained in the ATM address interrogation request received from the originating terminal, and the ATM address. Accordingly, if an interrogation request for the above-mentioned ATM address is issued after registration, it is unnecessary to broadcast this interrogation request; the ATM address can be obtained in simple fashion from the ATM address table.

Furthermore, if the ATM address table **21***a* is full when the prescribed terminal has answered with the ATM address, the server **21** erases the oldest corresponding relationship referred to and newly registers the corresponding relationship between the protocol address of the terminal and the ATM address, of which it has been notified, in the ATM address table. If this arrangement is adopted, a large-capacity ATM address table (data base) will be unnecessary and the scale of the server hardware can be minimized. Further, by arranging is so that a terminal periodically sends an ATM address interrogation request for its own terminal to the server, the corresponding relationship between the terminal's own protocol address and the ATM address can be kept in the ATM address table at all times.

(B) ATM-LAN of the present invention

(a) Overall configuration

FIG. **2** is a diagram showing the basic configuration of an ATM-LAN according to the present invention.

As shown in FIG. **2**, the terminals **11**~**14** are connected to the server **21** by respective transmission lines **41**~**44** for ATM cells. The terminals and the server are accommodated by the ATM exchange **31**.

The terminals **11**, **12**, **13**, **14** have respective request generating means **11***a*, **12***a*, **13***a*, **14***a* for sending an ATM address interrogation request to the server **21** if the ATM address of another party's terminal is unknown at the time of communication; answering means **11***b*, **12***b*, **13***b*, **14***b* which communicate with the other party's terminal via the ATM exchange **31** using an ATM address of which it has been notified by the server in response to an interrogation request; and answering means **11***c*, **12***c*, **13***c*, **14***c* each of which answers the server **21** with its own ATM address if a

rotocol address contained in an ATM address interrogation equest transferred from the server **21** agrees with its own rotocol address.

The server **21** includes the ATM address table **21***a* for toring the corresponding relationship between the protocol ıddress and ATM address of each terminal; the search/ egistration means **21***b* which, when an ATM address inter- ogation request has been received from a terminal, retrieves he ATM address corresponding to the protocol address :ontained in this interrogation request from the ATM address able **21***a* and registers the new corresponding relationship in he ATM address table **21***a*; the broadcast means **21***c* which, f an ATM address for which it has been interrogated by a .erminal is not obtained from the ATM address table **21***a*, ransfers (broadcasts) an ATM address interrogation request :o all terminals via the ATM exchange **31**; and the answering neans for answering a terminal, which has issued the ıbove-mentioned interrogation request, with the ATM ıddress for which it has been interrogated.

As illustrated in FIG. **3**, the ATM address table **21***a* holds the corresponding relationship between the protocol address and ATM address of each terminal as well as the time at which reference was made to the corresponding relationship. If a terminal does not know the ATM address of another party's terminal at the time of communication, the terminal sends the server **21** an interrogation request for the ATM address. Upon receiving the ATM address interrogation request from the terminal, the search/registration means **21***b* of the server **21** checks to determine whether the ATM address corresponding to the protocol address contained in the request has been registered in the ATM address table **21***a*. If the ATM address has been registered in the ATM address table **21***a*, the search/registration means **21***b* updates the reference time and enters the ATM address into the answering means **21***d*. If the ATM address for which the server has been interrogated has not been registered in the ATM address table **21***a*, then all terminals are interrogated to acquire the ATM address. In this case, the search/registration means **21***b* correlates the acquired ATM address and the reference time with the protocol address and stores this in the ATM address table **21***a*.

With reference again to FIG. **2**, the ATM exchange **31** includes an ATM switch **32**, terminal accommodating sections **33***a*~**33***d* and a server accommodating section **34**. The terminal accommodating sections **33***a*~**33***d* add a tag (routing information) onto a cell entered from the respective terminal, replaces the VPI/VCI and sends the result to the ATM switch **32**. Further, the terminal accommodating sections **33***a*~**33***d* remove the tag from a cell entered from the ATM switch **32** and then sends the cell to the respective one of the transmission lines **41**~**44**. The server accommodating section **34** adds a tag (routing information) onto a cell entered from the server **32**, replaces the VPI/VCI and sends the result to the ATM switch **32**. Further, the server accommodating section **34** removes the tag from a cell entered from the ATM switch **32** and then sends the cell to the server **21**.

(b) ATM cell

As shown in FIG. **4**A, an ATM cell is composed of a 53-byte, fixed-length block in which five bytes constitute a header HD and the remaining 48 bytes constitute an information field (payload) DT. The header HD contains a virtual channel identifier (VCI) for call identification so adapted that a destination can be ascertained even after data is broken down into blocks; a virtual path identifier (VPI) for specifying a path; a generic flow control (GFC) used to control flow between links; payload type (PTI); a cell loss priority

(CLP) and a header error control (HEC), which is a code for header error revision. Before this ATM cell is fed into the ATM switch **32**, the terminal accommodating sections **33***a*~**33***d* add on a one-byte routing tag TAG and update the VPI/VCI, as shown in FIG. **4**B.

(c) Operation when ATM address of other party's terminal is already known

Assume by way of example that an operation is performed in which terminal (originating terminal) **11** calls terminal (terminating terminal) **13**. (This is an operation for entering the ATM address of the terminating terminal **13**.) A cell assembler within the originating terminal divides a set-up message (data which includes the ATM address of the original terminal and the ATM address of the terminating terminal, etc.) into cell units, adds a signaling VCI onto each item of divided data to generate a signal cell and sends the signal cell to the ATM exchange **31**. If a signal device (not shown) in the ATM exchange **31** receives the signal cell, the device assembles the information contained in the signal cell and sends the information to a CPU (not shown). On the basis of the received message, the CPU performs call processing control, decides the VPI/VCI and assigns a prescribed VCI to the originating terminal and terminating terminal.

The CPU of the ATM exchange **31** correlates the VCI of the originating terminal **11** with a routing table within the terminal accommodating section **33***a* and registers information (tag information) specifying the outgoing line of the cell having this VCI as well as a VPI/VCI for replacement.

When a path is formed between the originating terminal **11** and terminating terminal **13**, the originating terminal **11** disassembles the data to be transmitted into prescribed byte lengths, creates a cell upon adding on a header containing the assigned VCI mentioned above and sends the cell to the ATM exchange **31**. When the cell enters from the terminal **11** via a prescribed incoming highway (in-line) **41**, the terminal accommodating section **33***a* of the ATM exchange **31** adds on the tag information TAG (see FIG. **4**B) upon referring to the routing table and sends the result to the ATM switch **32** upon replacing the VPI/VCI. On the basis of the tag, the ATM switch **32** sends the ATM cell to a prescribed outgoing highway (out-line) **43**. As a result, the cell outputted by the original terminal **11** arrives at and is accepted by the terminating terminal **13** via the path decided by call control.

Thereafter, the originating terminal **11** sends the cell to the terminating terminal **13** in successive fashion. The terminating terminal **13** assembles the information field DT contained in the received cell and restores the original data.

(d) Tag information

FIG. **5** is a diagram showing the detailed composition of the ATM cell to which the tag TAG has been added. TAG represents one-byte tag information, HD a five-byte header and PLD a 48-byte payload. The header HD contains the virtual path identifier VPI, the virtual channel identifier VCI, the generic flow control GFC used in flow control between links, a payload type PTI, the cell loss priority CLP and the header error code HEC.

The tag includes a copy designating bit C (in which "0" indicates one-to-one communication and "1" represents broadcast communication), an inter-switch path selection HW (a1, a2) (in case of a 4×4 ATM switch), and a reserve bit RES for when the switch is enlarged in scale.

FIG. **6** is a table for describing the relationship between the tag information and outgoing path. The path of the entered ATM cell is decided by the four bits C, a1, a2 and S. In FIG. **6**, "x" signifies "don't care" (i.e., the bit may be "0" or "1"), and the black circles indicate output to an outgoing path.

Further, C=1, S=0 signifies broadcast, with the ATM switch 32 outputting the input cell to outgoing paths of all terminals with the exception of the server. C=0, S=1 signifies output solely to the server, with the ATM switch 32 outputting the input cell solely to the server. C=0, S=0 signifies output of the cell to an outgoing path that conforms to the combination of a1 and a2, with the ATM switch 32 outputting the input cell to the prescribed outgoing path that conforms to the combination of a1 and a2.

(e) ATM switch

FIG. 7 is a diagram showing the construction of an n×n (n=3) ATM switch. The ATM switch includes tag information detection circuits I_1~I_3, transmission information delay circuits D_1~D_3, demultiplexers DM_1~DM_3, tag information decoding circuits DEC_1~DEC_3, which construct a cell distribution unit CELD, buffer memories such as FIFO (first-in, first-out) memories FM_{11}~FM_{33}, selectors SEL_1~SEL_3, and arrival order management FIFOs AOM_1~AOM_3. Each arrival order management FIFO (AOM_1~AOM_3) is connected to the output terminals of the information decoding circuits DEC_1~DEC_3 and stores the order in which cells arrive at the corresponding three buffer memories FM_{11}~FM_{13}, FM_{21}~FM_{23}, FM_{31}~FM_{33}. These FIFOs control the corresponding selectors SEL_1~SEL_3 so that cells are read out of the three buffer memories in the order of cell arrival and sent to outgoing lines #1~#3.

Cells that enter input terminals #1~#3 have the format shown in FIG. 5. Detection lines I_i (i=1~3) extract the tag information TAG contained in the input signal and send the information to the decoder circuits D_i (i=1~3). If the entering tag information TAG indicates the output terminal #j (j=1~3), the decoder circuit DEC_i operates the demultiplexer DM_i by a changeover signal S_i to send the cell to the FIFO memory FM_{ji}. For example, if the tag information TAG contained in the cell which has entered from the input terminal #1 indicates output terminal #2, the decoder circuit DEC_1 operates the demultiplexer DM_1 so that the information from the input terminal #1 enters FM_{21}. The arrival order management FIFO (AOM_i) is connected to the output terminals of the tag information decoding circuits DEC_1~DEC_3 and stores the order in which cells arrive at the corresponding three buffer memories FM_{i1}~FM_{i3}. For example, if cells arrive in the order of buffer memory $FM_{11}\rightarrow FM_{12}\rightarrow FM_{13}\rightarrow FM_{12}\rightarrow\ldots$, buffer memory identification codes are stored in the arrival order management FIFO (AOM_1) in the order of cell arrival, i.e., in the manner $1\rightarrow 2\rightarrow 3\rightarrow 2\rightarrow\ldots$. Thereafter, the arrival order management FIFO (AOM_1) controls the corresponding selector SEL_i so that cells are read out of the three buffer memories FM_{i1}~FM_{i3} in the order of cell arrival and sent to the outgoing line #i.

A buffer function is thus obtained by providing the FIFO memory FM_{ij} with a capacity equivalent to a plurality of cells. This makes it possible to deal satisfactorily with a case in which there is a temporary increase in transmission data. Further, since cells are read out of the buffer memories FM_{i1}~FM_{i3} in the order of cell arrival, equal numbers of cells reside in the buffer memories FM_{i1}~FM_{i3}. This is helpful in avoiding situations in which cells are discarded owing to overflow of the buffer memories.

In FIG. 7, an ATM switch for which n=3 holds is illustrated for the sake of explanation. However, an ATM switch in which n=5 holds can be readily implemented through a similar arrangement. In such case, tag information decoding circuits DEC_1~DEC_5 would perform the decoding processing shown in FIG. 6, the input cells would be stored in FIFO buffers FM_{ij} conforming to the prescribed outgoing

ines (outputs 1~5) and the cells would be stored in the rrival order management FIFOs in the order of arrival.

FIG. 8 is diagram showing a simplified representation of he ATM switch. Buffer memories FM_{11}~FM_{mn} are placed it the intersections between m-number of input links and n-number of output links. The ATM switch of FIG. 7 :orresponds to the portion surrounded by the dashed line.

(f) Broadcast from server

In a case where an ATM address of another party's erminal requested by a certain terminal has not been registered in the ATM address table 21*a*, the server 21 transfers (broadcasts) an interrogation request cell for the ATM address to all terminals via the ATM exchange 31.

FIG. 9 is a diagram for describing the broadcast method. The value of the VPI/VCI of the broadcast cell outputted by the server 21 is decided on as being a fixed value (=FF-FFFF) beforehand.

The broadcast means 21*c* of server 21 enters an ATM cell into ATM exchange 31, the ATM cell having ① FF-FFFF as VPI/VCI, ② a protocol address of the other party's terminal as data and ③ data to the effect that the cell is an interrogation for the ATM address.

In a case where VPI/VCI=FF-FFFF holds, the server accommodating section 34 of the ATM exchange 31 adds tag information TAG (C=1, S=0) onto the input cell and enters the cell into the ATM switch 32. As a result, the ATM switch 32 outputs the ATM cell to the outgoing lines (outputs 1~4) of all terminals via the buffers FM_{51}~FM_{54} and transfers the cell to all terminals.

In summary, the server 21 and all terminals 11~14 are interconnected beforehand in the ATM exchange 31 by PVCs (permanent virtual channels) having identical values. When an interrogation request cell having the above-mentioned PVC has entered from the server 21, a cell copy is made in the ATM exchange 31 and the interrogation request cell is transferred to all terminals 11~14.

More specifically, when the VPI/VCI of the broadcast cell is FF-FFFF and the cell for which VPI/VCI =FF-FFFF holds has entered from the server 21, the server accommodating section 34 adds on the tag information TAG so that the cell will be entered into all terminals and transfers the tag to the ATM switch 32. On the basis of the tag information TAG, the ATM switch 32 broadcasts the input cell to all terminals.

It should be noted that all terminals 11~14 are divided up into a plurality of groups in advance, the server 21 transfers an interrogation request cell to all terminals of the first group and performs monitoring to determine whether a prescribed terminal has answered with the ATM address within a set period of time. If notification of the ATM address is not received within the set time period, the server transfers the interrogation request cell to all terminals of the next group. Thus, the server transfers the interrogation request cell group by group while successively changing the group until the prescribed terminal answers with the ATM address.

(g) Control for sending/receiving ATM-ARP message

Control for sending and receiving an ATM-ARP message (an ATM address interrogation message/ATM address answer message) is performed in the manner set forth below.

(g-1) A control connection is set beforehand through the following steps ①–③:

① The VPI/VCI of the cell for the ATM-ARP message on each of the terminal lines 41~44 is made FF-FFFF. More specifically, the VPI/VCIs of the ATM address interrogation cells sent from the terminals 11~14 to the server 21 are FF-FFFF.

② VPI/VCIs are assigned to terminals in regular order on the server side. That is, the VPI/VCIs of the cells for the

ΓM-ARP messages sent from the server to the terminals 1~14 are made as follows, respectively:

00–0001, 00–0002, 00–0003, 00–0004.

③ In order to broadcast the ATM address interrogation cell to all terminals, the VPI/VCI of the cell is made FF-FFFF on the server side. This is in addition to ② above.

FIG. **10** is an explanatory view showing connections between the server **21** and terminals **11~14** in a case where control connections are set in the manner described above.

(g-2) General features of communication method

When cells (ATM address interrogation cells) for which VPI/VCI=FF-FFFF holds enter from the terminals **11~14**, the terminal accommodating sections **33***a*~**33***d* replace the VPI/VCIs with 00–0001~00–0004, add the tag information TAG (C=0, S=1) onto the cells and then transfer the cells to the ATM switch **32**.

On the basis of the tag information TAG (C=0, S=1), the ATM switch **32** transfers the input cells (ATM address interrogation cells) to the server **21**.

If an ATM address interrogation cell is received, the server **21** obtains the ATM address and notifies the terminal that issued the interrogation cell. It should be noted that the server **21** can identify from which terminal a cell has arrived depending upon the VPI/VCI (=00–0001, ~00–0004) updated by the terminal accommodation sections **33***a*~**33***d*.

The answer cells of the ATM addresses from the server **21** to the terminals **11~14** have VPI/VCIs (=00–0001~00–0004) conforming to the terminals which are the destination of transmission. When the answer cell enters, the server accommodation section **34** updates the value of the VPI/VCI from 00–0001~00–0004 to FF-FFFF, adds on the tag information TAG (S=0, C=0, a1, a2=destination terminals) and transfers the cell to the ATM switch **32**. On the basis of the tag information TAG, the ATM switch **32** switches the input cell, sends the cell to the line to which the prescribed terminal is connected and enters the cell into this terminal.

In the case of a broadcast, on the other hand, the interrogation request cell sent from the server **21** has FF-FFFF as the VPI/VCI. When the interrogation cell for which VPI/VCI=FF-FFFF holds enters, the server accommodating section **34** adds on the tag information TAG (C=1, S=0) specifying all paths and then transfers the cell to the ATM switch **32**. In this case, the value of the VPI/VCI is not changed. On the basis of the tag information TAG (C=1, S=0), the ATM switch **32** switches to all paths and enters the cell into all terminals.

(h) Communication sequence of the invention

A broadcast method of broadcasting an interrogation request to all terminal:

FIG. **23** is a diagram for describing the broadcast method. Terminals **1***a*, **1***b*, **1***c* are connected to an ATM-LAN **2**. According to the broadcast method, the ATM address interrogation request is broadcast within the network if the ATM address of the other party's terminal is unknown at the moment a communication request is generated, and a prescribed terminal responds to this interrogation by answering with its own ATM address. For example, if the ATM address of terminal **1***b* is unknown to the terminal **1***a* when this terminal communicates with the terminal **1***b* in FIG. **23**, the terminal **1***a* broadcasts an ATM address interrogation request cell (which has the protocol address of terminal **1***b*) within the network. The terminal **1***b*, which is that terminal having a protocol address identical with that contained in the received cell, answers the terminal **1***a* with its own ATM address. The terminal **1***a* uses the received ATM address to call the terminal **1***b* and communicate with it.

If the ATM address of another party's terminal is unknown at the moment a communication request is issued in the broadcast method, a broadcast is made within the network and the terminal is interrogated directly. Unlike the server method, implementation is easy because it is unnecessary to create a data base in advance. However, in cases where frequent communication is made with an unspecified terminal whose ATM address is unknown, broadcast of the interrogation request is made whenever a communication request is issued. A problem which arises as a consequence is an increase in control traffic. This problem becomes particularly pronounced with an increase in the number of terminals or depending upon the scale of the network.

FIG. **11** is a diagram for describing the communication sequence of the present invention.

(1) The originating terminal **11** refers to its own cache memory and determines whether the ATM address of the other party has been registered. It should be noted that information regarding a party to be communicated with will not have been registered in the cache memory when power is introduced to the system. If the information has been registered, set-up is executed to set a path using this ATM address and communication is carried out. If the information has not been registered, however, the originating terminal **11** puts an ATM-ARP request (an ATM address interrogation request) message into the form of a cell and sends the cell to the server **21** in order to inquire as to the ATM address of the communicating party **14**. FIG. **12** illustrates the format of the ATM-ARP request message/answer message.

The message includes protocol type **100**, which indicates the type (IP, etc.) of host protocol; ATM address length **101**,

hich indicates address length of the ATM address used in ı ATM network; protocol address length **102**, which indiıtes address length (four bytes in case of protocol type IP) f the host protocol; an operation code ("1": request, "2": ıswer) **103**; ATM address (source address) **104** of the :questing terminal; a protocol address (source address) **105** f the requesting terminal; ATM address **106** of the target :rminal, which is all "1"s or all "0"s in case of a request ıessage, with the ATM address being inserted in case of the nswer message; and protocol address **107** of the target :rminal.

(2) Upon receiving the ATM-ARP request from the terninal **11**, the server **21** determines whether the ATM address :orresponding to the protocol address of the target terminal :ontained in the request has been registered in the ATM ıddress table **21***a*. If the ATM address has been registered, ın ATM-ARP answer message containing this information (ATM address) is formed into a cell and sent back to the :erminal **11**.

If the ATM address has not been registered, the server **21** transfers the ATM-ARP request to all terminals using the broadcast function of the ATM switch **32**.

(3) Upon receiving the ATM-ARP request transferred (broadcast) from the server **21**, each of the terminals **11** ~**14** determines whether the protocol address of the target terminal contained in this request agrees with its own protocol address. If agreement is achieved, the terminal forms the ATM-ARP answer message indicating its own ATM address into a cell and sends the message back to the server **21**.

(4) Upon receiving the ATM-ARP answer message from the terminal **14**, the server **21** obtains the ATM address d of the target terminal **14**. The search/registration means **21***b* correlates the ATM address d and the reference time with the protocol address D of the target terminal **14** and registers the correlation in the ATM address table **21***a*, as shown in FIG. **3**. If the ATM address table **21***a* is saturated (full), the entry having the oldest reference time is deleted and then a new entry is registered. It should be noted that an arrangement can be adopted in which, rather than storing the reference time, correlations are stored in order starting from the oldest correlations by the LRU (least recently used) method.

(5) Further, when the ATM-ARP answer message is received from the terminal **14**, the server **21** transfers the ATM address contained in the answer message to the requesting terminal **11** that transmitted the ATM-ARP request message.

(6) Upon receiving the ATM-ARP answer message at (2) or (5), the terminal **11** that issued the ATM-ARP request message at (1) above recognizes the ATM address of the communicating party **14**, correlates this ATM address with the protocol address and saves the correlation in its own cache memory.

(7) Further, the terminal **11** executes set-up using the ATM address of the communicating party, establishes a path and communicates with the terminal **14**.

Thus, in a case where the ATM address has been registered in the ATM address table **21***a*, the server **21** operates in the same manner as in the conventional server method. If the ATM address has not been registered in the ATM address table **21***a*, however, the server **21** can obtain the target ATM address by broadcast of the ATM-ARP request message. Accordingly, the server need not register the information of all terminals in the ATM address table **21***a* in advance, and the stored content of the ATM address table can be perfected by a learning function. This is effective in terms of implementing the ATM address table by small-scale circuitry.

FIG. **13** is a diagram for describing another communication sequence of the present invention. This is for a case in

hich an ATM address for which an inquiry has been made y the ATM-ARP request from a certain terminal has been egistered in the ATM address table 21*a*. Specifically, this is n example of a case in which the terminal 12 communicates ith the terminal 14 after the communication sequence of IG. 11.

(1) The terminal 12 that has issued the communication equest refers to its own cache memory and determines whether the ATM address of the communicating party has een registered. If the ATM address has not been registered, et-up is executed to set a path using this ATM address and ommunication is carried out. If the information has not been registered, however, the terminal 12 puts the ATM-ARP request message into the form of a cell and sends the nessage to the server 21 in order to inquire as to the ATM ddress corresponding to the protocol address of the communicating party 14.

(2) Upon receiving the ATM-ARP request from the terminal 12, the server 21 determines whether the ATM address corresponding to the protocol address of the terminal 14 contained in the request has been registered in the ATM address table 21*a*. If the ATM address has been registered, an ATM-ARP answer message containing this information (ATM address) is formed into a cell and is sent back to the terminal 12.

(3) Upon receiving the ATM-ARP request from the server 21, the terminal 12 recognizes the ATM address of the communicating party 14, correlates this ATM address with the protocol address and saves the correlation in its own cache memory.

(4) Next, the terminal 12 executes set-up using the ATM address of the communicating party, establishes a path and communicates with the terminal 14.

Thus, in a case where the ATM address has been registered in the ATM address table 21*a*, the server 21 operates in the same manner as in the conventional server method.

(i) Processing at each part of communication sequence

(i-1) Processing by originating terminal FIG. 14 is a flowchart of processing executed by an originating terminal when a communication request is issued.

When a communication request is issued (step 201), the terminal refers to its own cache memory and determines whether the ATM address of the communicating terminal is an entry in the memory (step 202). If ATM address is an entry, the terminal executes set-up using this ATM address, establishes a path and performs communication (step 203).

If the ATM address is not an entry in the cache memory, however, the terminal puts the ATM-ARP request message into the form of a cell and sends the message to the server 21 in order to inquire as to the ATM address corresponding to the protocol address of the communicating party (step 204).

The terminal then waits for transmission of the ATM-ARP answer message from the server 21 (step 205). If the ATM-ARP answer message is received, then the terminal registers the ATM address of the other party's terminal contained in the message in the cache memory (step 206) and subsequently executes set-up using this ATM address, establishes a path and performs communication (step 203).

(i-2) Processing by terminating terminal

FIG. 15 is a flowchart of processing executed by each terminal when the server broadcasts the ATM-ARP request message to all terminals.

Upon receiving the ATM-ARP request message (an ATM address interrogation request message) from the server 21 (step 301), each terminal determines whether the protocol address of the target terminal contained in this request agrees

ith its own protocol address (step **302**). If agreement with . own protocol address is not achieved, the terminal ends ocessing. If agreement is achieved, the terminal creates an TM-ARP response message in order to give notice of its vn ATM address and sends the message back to the server l in the form of a cell (step **303**).

(i-3) Processing flow of server

FIG. **16** is a flowchart of processing executed by the :rver for receiving an ATM-ARP request.

Upon receiving an ATM-ARP request from a prescribed :rminal (step **400**), the server **21** registers the corresponding :lationship between the protocol address and ATM address :f the original terminal contained in the request, as well as ıe time, in the ATM address table **21***a* (step **401**).

Next, the server **21** determines whether the ATM address :orresponding to the protocol address of the target terminal ıas been registered in the ATM address table **21***a* (step **402**). f the ATM address has been registered, the reference time n the ATM address table **21***a* is updated (step **403**). The :erver **21** thenceforth creates an ATM-ARP response mes-:age in order to give notice of the above-mentioned ATM address and'sends the message back to the requesting terminal in the form of a cell (step **404**).

On the other hand, if it is found at step **402** that the desired ATM address has not bee registered, the server **21** transfers the ATM-ARP request to all terminals using the broadcast function of the ATM switch **32** (step **405**). Next, the server waits for reception of the ATM-ARP answer message in response to the above-mentioned ATM-ARP request (step **406**).

If the ATM-ARP answer message is received from a prescribed terminal, the server **21** newly registers the ATM address contained in this message as well as the reference time in the ATM address table **21***a* (step **407**).

Processing for registering the ATM address anew is as follows: The server **21** checks to see whether the ATM address table **21a** is full (step **407a**). If the table is not full, [the server **21**] the server **21** refers to the ATM address using the protocol address as index, and newly registers the ATM address and reference time in the ATM address table **21a** in correspondence with the protocol address of the terminal (step **407b**). In a case where the ATM address table **21a** is full, the server deletes the entry having the oldest reference time to form a vacancy (step **407c**) and registers the new entry (the ATM address and reference time) in this vacancy (step **407b**).

After making the new registration, the server **21** creates an ATM-ARP answer message to notify of the ATM address and sends the message back to the requesting terminal in the form of a cell (step **404**).

The foregoing is for a case in which the ATM-ARP request is broadcast to all terminals en masse at step **405**. However, all of the terminals **11**–**14** can be divided up into a plurality of groups and the request can be broadcast group by group.

FIG. **17** is a flowchart of such "multicasting".

If it is found at step **402** in FIG. **16** that the desired ATM address has not been registered, the server **21** performs the operation 1→i (step **405***a*) and then transfers the ATM-ARP request to all terminals of an ith group using a multicasting function of the ATM switch **32** (step **405***b*). Next, the server **21** determines whether the ATM-ARP answer message which is a response to the above-mentioned ATM-ARP request has been transmitted from the prescribed terminal (step **405***c*). If the answer message has not been transmitted, the server determines whether time that has elapsed from the multicast has surpassed a set time (step **405***d*). If the decision rendered is NO, then the program jumps to step **405***c* and the server waits for reception of the ATM-ARP answer message.

If the ATM-ARP answer message is not received even ›on elapse of the set time, the group is incremented by the ›eration i+1→i (step 405*e*) and processing from step 405*b* ıward is executed with regard to the next step.

If the ATM-ARP answer message is received from the ·escribed terminal within the set time, then the program ımps to step 407 of FIG. 16 and executes the processing om this step onward.

It should be noted that the ATM address table 21*a* holds ·-number of corresponding relationships between protocol ddresses and ATM addresses referred to most recently. ccordingly, by arranging is so that a terminal periodically ends an ATM address interrogation request for its own ırminal to the server 21, the corresponding relationship etween the terminal's own protocol address and the ATM ddress can be kept in the ATM address table at all times.

(j) Construction of server

FIG. 18 is a block diagram showing the construction of the server 21. The server 21 includes the ATM address table 21a, a cell receiver 51, a message receiver 52, a reception buffer 53, a CPU 54, a main memory 55, a working memory 56, a transmission buffer 57, a message transmitter 58 and a cell transmitter 59.

The operation of each unit in response to an ATM-ARP :equest will now be described.

Upon receiving a cell from the ATM exchange 31, the cell receiver 51 assembles a cell for every VPI/VCI and transfers the cell to the message receiver 52. The latter transfers the message received from the cell receiver 51 to the reception buffer 53 and notifies the CPU 54, by means of an interrupt, of the fact that an ATM address interrogation request message or answer message has been received.

When the interrupt to notify of reception is generated, the CPU 54 reads in the message from the reception buffer 53, analyzes the operation code (see FIG. 12) contained in the message and identifies whether the message is the ATM address interrogation request message or answer message.

When received message is interrogation request message

If the received message is the interrogation request message, the CPU 54 registers, in the table 21a, the corresponding relationship between the protocol address and ATM address of the originating terminal contained in the message. Next, the CPU 54 executes processing to search the ATM address table 21a, using the protocol address of the target as an index. If the target ATM address has been registered in the ATM address table 21a, the CPU 54 creates an answer message for giving notice of the ATM address, writes the message in the transmission buffer 57 and requests the message transmitter 58 to transfer the answer message to the originating terminal based upon the prescribed VPI/VCI.

If the target ATM address has not been registered in the ATM address table 21*a*, however, the CPU 54 transfers the interrogation request message stored in the reception buffer 53 to the transmission buffer 57 and requests the message transmitter 58 to carry out a transfer based upon the VPI/VCI for the purpose of broadcast.

When received message is answer message

If the received message is the answer message, on the other hand, the CPU 54 correlates the target ATM address contained in the answer message with the target protocol address, registers the correlation in the ATM address 21*a* and transfers the answer message in the reception buffer 53 to the transmission buffer 57 as is. Thereafter, the CPU 54 requests the message transmitter 58 to transfer the above-mentioned answer message to the originating terminal based upon the prescribed VPI/VCI.

Upon receiving the transmission request from the CPU 54, the message transmitter 58 transfers the data in the

ransmission buffer 57 to the cell transmitter 59 and gives iotice of the value of the VPI/VCI. The cell transmitter 59 ransfers the message, which has been received from the nessage transmitter 58, to the ATM exchange 31 upon 'orming the message into a cell based upon the VPI/VCI of vhich it has been notified.

(k) Construction of terminal

FIG. 19 is a diagram showing the construction of the terminals 11~14. Numeral 60 denotes the main body of a work station (WS) or personal computer (PC), which has an ATM interface card 61. The ATM interface card 61 includes a system-bus interface circuit 62, a local processor 63, a local memory 64, a buffer memory 65, a CLAD (cell assembly/disassembly) circuit 66 and a physical interface circuit 67.

The operation of each component of the ATM interface card will now be described.

The ATM interface card 61 mounts the local processor 63 and the local memory 64, which stores various programs, and is connected with the WS or PC 60 by loose coupling implemented by communication between memories. Examples of the programs are a program for managing the overall ATM interface card, a control program for the ATM address notification request and for giving notice of an answer, a communication control program, etc.

The system-bus interface circuit 62 has a control mechanism for communicating with the WS or PC 60. The circuit 62 provides an interface dependent upon the WS or PC. A communication request message generated by an application in the WS is transferred to the local memory 64 via the system-bus interface circuit 62.

Upon receiving the communication request message, the local processor 63 obtains the ATM address of the other party's terminal based upon the destination protocol address contained in the message. That is, since the correspondence between the protocol address and the ATM address has been stored in, say, a storage area (address cache memory) in the local memory 64, the processor 63 searches the address cache memory.

If the ATM address corresponding to the destination protocol address has not been registered in the cache memory, the local processor 63 creates the ATM address interrogation request message, stores the message in the buffer memory 65 and starts up the CLAD circuit 66. As a result, the CLAD circuit 66 forms the ATM address interrogation request message into a cell (VPI/VCI=FF-FFFF) and transfer the cell to the ATM exchange 31 via the physical interface circuit 67.

When notice of the ATM address in response to the interrogation request is received from the ATM exchange 31, the local processor 63 registers the ATM address in the address cache memory. Thereafter, the local processor 63 starts up the communication control program, creates a set-up message using the received ATM address under the control of the communication program and stores the message in the buffer memory 65. The CLAD circuit 66 forms the set-up message into a cell and transfers the cell to the ATM exchange 31 via the physical interface circuit 67. It should be noted that if the ATM address has been registered in the address cache memory, the local processor 63 creates the set-up message immediately without making an inquiry and transfers the message to the ATM exchange 31.

The ATM exchange 31 executes call processing in response to the set-up message and sends back a connect message. Upon receiving the connect message via the physical interface circuit 67, the CLAD circuit 66 forms the message into a cell, stores the cell in the buffer memory 65

and notifies the local processor **63** of receipt of the message. As a result, the local processor **63** accepts the connect message from the buffer memory **65**, verifies establishment of the communication path based upon the message and terminates the communication control program.

Thereafter, the local processor **63** starts message transfer using the identifier (VPI/VCI) of the communication path of which it has been notified by the connect message. More specifically, in response to establishment of the communication path, the local processor **63** stores the message received from the WS or PC in the buffer memory **65** and notifies the CLAD circuit **66** of the identifier (VPI/VCI) of the set communication path. As a result, the CLAD circuit **66** forms the message in the buffer memory **65** into a cell using the value of the VPI/VCI and transfers the cell to the ATM exchange **31** via the physical interface circuit **67**.

In a case where a cell stream is received from the ATM exchange **31** via the physical interface circuit **67**, the CLAD circuit **66** disassembles the cell and assembles a message, stores the message in the buffer memory **65** and then notifies the local processor **63** of the fact that the message has been received. In response to notification of receipt from the CLAD circuit **66**, the local processor **63** accepts the message from the buffer memory **65** and transfers the message to the WS via the system-bus interface circuit **62**.

(l) Construction of server accommodation section

FIG. **20** is a block diagram showing the construction of a server accommodating section **34**. The construction is the same for the terminal accommodating sections **33***a*–**33***d* as well. The server accommodating section **34** includes a physical interface **71** for sending cells to and receiving cells from the server, a traffic monitoring circuit **72** for determining whether cells are being transmitted at a declared speed, a header tag table (routing table) **73** which stores ① tag information and ② a new VPI/VCI, which is to be replaced, in correspondence with a VCI, a header replacing circuit **74**, a switching interface circuit **75** for administering interfacing with the ATM exchange **31**, a cell buffer **76** which stores a cell entered from the ATM exchange **31**, and a traffic shaper **77** which performs control in such a manner that cells are transmitted at a desired traffic.

In accordance with the present invention, the arrangement is such that if an ATM address has been registered in the ATM address table of a server when an interrogation request has been issued for this ATM address, the target ATM address can be obtained through an operation similar to that performed in the conventional server method. If the ATM address has not been registered in the ATM address table, however, the target ATM address can be obtained by broadcasting the interrogation request for the ATM address. In other words, according to the invention, ATM addresses are managed by making joint use of the server method and broadcast method. This makes it possible to hold down at increase in control traffic. Moreover, ATM addresses can be perfected by successively registering corresponding relationships, which have been found using the broadcast method, in the ATM address table. In addition, it is possible to dispense with a task for initially setting the ATM address table and a task for updating the table when terminals are added on or moved.

Further, in accordance with the present invention, all terminals are divided up into a plurality of groups. When a broadcast is made, the server transfers the ATM address interrogation request cell to all terminals of the first group. If there is no notice of answer of the ATM address within a set time, the server transfers the interrogation request cell to all terminals of the next group. Thenceforth, and in similar

shion, the server transfers the interrogation request cell hile successively changing groups until the prescribed rminal answers with the ATM address. As a result, there is good possibility that the desired ATM address will be otained without broadcasting the interrogation request cell) all terminals. Consequently, an increase in traffic can be ippressed.

Furthermore, in accordance with the invention, (1) upon :eiving notification of the ATM address from the pre- cribed terminal, the server newly registers the correspon- ence between the protocol address of this terminal and the TM address, of which it has been notified, in the ATM ddress table. Further, (2) the server registers, in the ATM ddress table, the corresponding relationship between the rotocol address of the originating terminal, which address s contained in the ATM address interrogation request eceived from the originating terminal, and the ATM ddress. Accordingly, if an inquiry for the above-mentioned ATM address is issued after registration, it is unnecessary to oroadcast this interrogation request; the ATM address can be obtained in simple fashion from the ATM address table.

Further, in accordance with the present invention, if the ATM address table is full when the prescribed terminal has answered with the ATM address, the server erases the oldest corresponding relationship referred to and newly registers the ATM address of which it has been notified in the ATM address table. As a result, a large-capacity ATM address table is unnecessary and the scale of the server hardware can be minimized.

Furthermore, in accordance with the invention, a terminal periodically sends an ATM address interrogation request for its own terminal to the server, whereby the corresponding relationship between the terminal's own protocol address and the ATM address can be kept in the ATM address table at all times.

As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

What is claimed is:

1. An address management method in a communication system equipped with a plurality of terminals, a server having an address table for storing a corresponding relationship between a protocol address and terminal address of each terminal, and an exchange which accommodates each terminal and the server, said method comprising:

a first step in which an originating terminal sends a terminal address interrogation request to the server if the terminal address of another party's terminal is unknown at the time of communication;

a second step in which the server, upon receiving the terminal address interrogation request from the terminal, refers to the address table and searches for a terminal address corresponding to a protocol address contained in said interrogation request;

a third step in which, if a terminal address corresponding to said protocol address is obtained from the address table, the server notifies the terminal of this terminal address;

a fourth step in which, if the terminal address is not obtained from the address table, the server transfers the terminal address interrogation request containing said protocol address to all terminals via the exchange;

a fifth step in which, when each terminal receives the terminal address interrogation request transferred from

the server, the terminal determines whether the protocol address contained in said interrogation request agrees with its own protocol address and notifies the server of its own terminal address if agreement is achieved; and

a sixth step in which the server notifies the originating terminal of the terminal address of which it has been notified.

2. The method according to claim 1, wherein said fourth ep includes:

a step in which the exchange connects the server with all terminals by PVCs (permanent virtual channels) having identical values; and

a step in which, when a terminal address interrogation request having said identical value for PVC has entered from the server, the exchange performs cell copying, whereby said interrogation request cell is transferred to all terminals.

3. The method according to claim 1, wherein said fourth tep includes:

a step in which the exchange connects the server with all terminals by PVCs (permanent virtual channels) having identical values and divides all terminals into a plurality of groups;

a step in which, when a terminal address interrogation request having said identical value for PVC has entered from the server, the exchange performs cell copying, whereby said interrogation request cell is transferred to all terminals in a first group;

a step in which the server performs monitoring to determine whether a prescribed terminal has answered with a terminal address within a set period of time;

a step in which the server sends the interrogation request cell to all terminals of the next group if no terminal answers with a terminal address within the set period of time; and

a step in which the server transfers the interrogation request while successively changing the group until a prescribed terminal answers with a terminal address.

4. The method according to claim 1, further comprising a seventh step in which, when the server receives the answer of the terminal address from the terminal, the server newly stores the corresponding relationship between said protocol address and the terminal address, of which it has been notified, in the address table.

5. The method according to claim 1, further comprising an eighth step in which the server stores, in the address table, the corresponding relationship between the protocol address of the originating terminal and the terminal address which are contained in the terminal address interrogation request received from said originating terminal.

6. The method according to claim 1, further comprising:

a seventh step in which, when the server receives the answer of the terminal address from the terminal, the server deletes a corresponding relationship, referred to least recently, between a protocol address and terminal address if the address memory is full; and

an eight step in which the server newly stores the corresponding relationship between said protocol address and the terminal address, of which it has been notified, in the address table.

7. The method according to claim 1, further comprising a ninth step in which each terminal sends periodically the server an interrogation request for its own terminal's address, whereby the corresponding relationship between its own terminal's protocol address and the terminal address is kept in the address table.

8. A communication system equipped with a plurality of terminals, a server having an address table for storing a corresponding relationship between a protocol address and terminal address of each terminal, and an exchange which accommodates each terminal and the server, wherein each of said terminals comprises:

means for sending a terminal address interrogation request to the server if the terminal address of another party's terminal is unknown at the time of communication;

communication means for communicating with the other party's terminal via the exchange using a terminal address of which it has been notified by the server in response to the interrogation request; and

Terminal address answering means for answering the server with its own terminal address if a protocol address contained in a terminal address interrogation request transferred from the server agrees with its own protocol address; and

said server comprises:

means for referring to the address table and searching for a terminal address corresponding to a protocol address contained in a terminal address interrogation request from a terminal;

means which, if a terminal address corresponding to said protocol address has not been registered in the address table, is for transferring the terminal address interrogation request containing said protocol address to all terminals via the exchange; and

means for notifying the terminal which has issued the interrogation request of a terminal address found from the address table or of a terminal address obtained by an answer from a terminal.

9. The communication system according to claim 8, wherein said exchange comprises:

means for connecting the server with all terminals by PVCs (permanent virtual channels) having identical values; and

means which, when a terminal address interrogation request having said identical value for PVC has entered from the server, is for performing cell copying and transferring said interrogation request cell to all terminals.

10. The communication system according to claim 8, wherein said server has registration means which, when the server receives the answer of the terminal address from a prescribed terminal, is for newly storing the corresponding relationship between a protocol address and the terminal address, of which it has been notified, in the address table.

11. The communication system according to claim 10, wherein when the server receives the answer of the terminal address from the prescribed terminal, said registration

means deletes a corresponding relationship, referred to least recently, between a protocol address and terminal address if the address memory is full.

12. A server in a communication system equipped with a plurality of terminals, the server for managing a corresponding relationship between a protocol address and terminal address of each terminal, and an exchange which accommodates each terminal and the server, said server comprising:

an address table for storing the corresponding relationship between a protocol address and terminal address of each of the plurality of terminals;

search means for referring to said address table and searching for a terminal address corresponding to a protocol address contained in a terminal address interrogation request from a terminal; and

interrogation means which, if a terminal address corresponding to the protocol address has not been registered in the address table, is for interrogating all terminals, via an exchange, for the terminal address corresponding to this protocol address; wherein in response to receipt of a terminal address interrogation request from an originating terminal, said search means refers to said address table to obtain the terminal address conforming to the protocol address contained in this terminal address interrogation request and, if this terminal address has not been registered, said interrogation means interrogates the terminals for terminal address.

13. The server according to claim 12, further comprising:

means for receiving notification of an answer from a prescribed terminal in response to the terminal address interrogation request; and

registration means for newly registering the corresponding relationship between the protocol address and the terminal address, of which it has been notified, in said address table.

14. The server according to claim 13, wherein when the server receives the answer of the terminal address from the prescribed terminal, said registration means deletes a corresponding relationship, referred to least recently, if said address memory is full, and registers the corresponding relationship between the protocol address and the terminal address, of which it has been notified, in said address table.

15. The server according to claim 12, wherein said terminal address interrogation means divides all terminals into a plurality of groups, interrogates all terminals of a first group for a terminal address and, if notification of answer of a terminal address is not received within a set period of time, interrogates all terminals of the next group for a terminal address.

* * * * *

16. In a network system having a server, the method comprising the steps of:

receiving by the server a terminal address interrogation request including a first address from an originating terminal;

referring by the server to an address table and searching by the server for the second address corresponding to the first address included in the terminal address interrogation request; and

transferring by the server the terminal address interrogation request including the first address to a plurality of terminals.

17. In a network system having a server, the method comprising the steps of:

receiving by the server a terminal address interrogation request including a first address from an originating terminal;

identifying by the server a second address based on the first address included in the terminal address interrogation request sent from the originating terminal; and

transferring by the server the terminal address interrogation request including the first address to a plurality of terminals when the server cannot identify the second address corresponding to the first address based on the first address.

18. The method according to claim 17, wherein the receiving and transferring the terminal address interrogation request uses ATM cells.

19. The method according to claim 18, wherein the identifying step includes:

searching in an address table for the second address corresponding to the first address included in the terminal address interrogation request.

20. The method according to claim 19, wherein the system includes a switch or exchange and wherein the transferring step includes:

a step in which the switch or exchange connects the server with the plurality of terminals by PVCs (permanent virtual channels) having identical values; and

a step in which, when the terminal address interrogation request in the form of a cell and having the identical value for the PVC is entered for the server, the switch or exchange performs cell copying, whereby the terminal address interrogation request cell is transferred to the plurality of terminals.

21. The method according to claim 19, wherein the system includes a switch or exchange, and wherein the transferring step includes:

a step in which the switch or exchange connects the server with the plurality of terminals by PVCs (permanent virtual channels) having identical values and divides the plurality of terminals into a plurality of groups;

a step in which, when the terminal address interrogation request in the form of a cell and having the identical value for PVC is entered from the server, the switch or exchange performs cell copying, whereby the terminal address interrogation request cell is transferred in a first group;

a step in which the server performs monitoring to determine whether a prescribed terminal has answered with its own address within a set period of time;

a step in which the server sends the terminal address interrogation request cell to terminals of the next group when no terminal answers with its own address with the set period of time; and

a step in which the server transfers the terminal address interrogation request while successively changing the group until a prescribed terminal answers with its own address.

22. The method according to claim 19, further comprising:

receiving by the server an answer including a second address corresponding to the first address from one of the plurality of terminals when the first address included in the terminal address interrogation request received by the one terminal is in agreement with its own first address; and

notifying by the server to the originating terminal of the second address corresponding to the first address.

23. The method according to claim 22, further comprising a step in which, when the server receives the answer including a second address from the one of the plurality of terminals, the server stores, in an address table, the corresponding relationship between the first address and the second address, of which it has been notified.

24. The method according to the claim 22, further comprising a step in which, when the server receives the answer including a second address from the one of the plurality of terminals, the server stores the corresponding relationship between the first address and the second address in place of the address table designated by an index value which is calculated based on a value of the first address or the second address.

25. The method according to claim 24, further comprising:

a step in which , when the server receives the answer including the second address from one of the plurality of terminals, the server deletes a corresponding relationship, referred to least recently, between a first address and a second address when the address table is full; and

a step in which the server stores, in the address table, the corresponding relationship between the first address and the second address.

26. The method, according to claim 19, further comprising a step in which the server periodically receives a terminal address interrogation request including a second address

from each terminal of the plurality of terminals, whereby the corresponding relationship between the first address of its own terminal and the second address is kept in an address table.

27. An address resolution system equipped with a plurality of terminals, a switch or exchange which accommodates each terminal of a plurality of terminals and a server, wherein each terminal of the plurality of terminals comprises:

means for sending a terminal address interrogation request including a first address to the server; and

means for answering the server with its own second address when a terminal address interrogation request including a first address transferred from the server agrees with its own first address; and the server comprises:

means for searching for in an address table the second address corresponding to the first address included in the terminal address interrogation request received from a terminal of the plurality of terminals;

means for transferring the terminal address interrogation request including the first address to the plurality of terminals and

means for notifying the originating terminal of the second address identified with the first address or obtained by an answer including the second address received from a terminal.

28. An address resolution system equipped with a plurality of terminals, a switch or exchange which accommodates each terminal of a plurality of terminals and a server, wherein each terminal of the plurality of terminals comprises:

means for sending a terminal address interrogation request including a first address to the server; and

means for answering the server with its own second address when a terminal address interrogation request including a first address transferred from the server agrees with its own first address; and the server comprises;

means for identifying a second address based on the first address included in the terminal address interrogation request sent from an originating terminal;

means for transferring the terminal address interrogation request including the first address to the plurality of terminals; and

means for notifying the originating terminal of the second address identified with the first address or obtained by an answer including the second address received from a terminal.

29. The address resolution system according to claim 28, wherein the switch or exchange comprises;

means for connecting the server with the plurality of terminals by PVCs (permanent virtual channels) having identical values; and

means which, when a terminal address interrogation request call having the identical PCV value is entered from the server, is for performing cell copying and transferring of the interrogation request cell to the plurality of terminals.

30. The address resolution system according to claim 28, wherein the server has registration means which when the server receives the answer including the second address from a prescribed terminal, is for storing the corresponding relationship between a first address and a second address in a place of an address table designated by an index value which is calculated based on a value of the first address or the second address.

31. The address resolution system according to claim 30, wherein when the server receives the answer including the second address from the prescribed terminal, the registration means deletes a corresponding relationship, referred to least recently, between a first address and a second address when a space of the memory is full.

32. A server comprising:

means for receiving a terminal address interrogation request including a first address from an originating terminal;

search means for referring to an address table and searching for the second address corresponding to the first address included in the terminal address interrogation request; and

means for transferring the terminal address interrogation request including the first address to a plurality of terminals

33. A server comprising:

means for receiving a terminal address interrogation request including a first address from an originating terminal;

identifying by the server a second address based on the first address included in the terminal address interrogation request sent from the originating terminal; and

means for transferring the terminal address interrogation request including the first address to a plurality of terminals when the server cannot identify the second address corresponding to the first address based on the first address.

34. The server according to claim 33, further comprising;

means for receiving a notification of an answer including a second address from a prescribed terminal in response to the terminal address interrogation request; and

means for newly registering the corresponding relationship between the first address and the second address in a place of the address table designated by an index value which is calculated based on a value of the first address or the second address, in the address table.

35. The server according to claim 34, wherein when the server receives the answer including the second address from the prescribed terminal, the registration means deletes a corresponding relationship, referred to least recently, when the address table is full, and

registers the corresponding relationship between the first address and the second address, of which it has been notified, in the address table.

36. The server according to claim 35, wherein the terminal address interrogation means divides terminals into a plurality of groups, interrogates terminals of a first group for a second address and, when a notification of an answer including a second address is not received within a set period of time, interrogates the terminals of the next group for a second address.

✓37. An apparatus comprising:

a receiver for receiving a terminal address interrogation request including a first address, and notifying a processor of a notification that the terminal address interrogation request has been received;

the processor for notifying a transmitter of a transmission request for transferring the terminal address interrogation request to a switch or exchange, based on the notification sent from the receiver; and

the transmitter for transmitting the terminal address interrogation request with a prescribed destination address for multicasting, based on the transmission request sent from the processor.

38. The apparatus of claim 37, wherein the receiver and transmitter communicate with a switch or exchange using ATM cells.

39. The apparatus of claim 38, further comprising an address table for storing a corresponding relationship between a first and second address of each terminal,

wherein , when the processor searches in said address table for the second address corresponding to the first address included in the terminal address interrogation request and obtains the second address, the processor notifies the transmitter of an answer including the second address for transmitting to the originating terminal, the transmitter

transmits the answer including the second address to the originating terminal via the switch or exchange, based on the answer sent from the processor.

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IN THE UNITED PATENT AND TRADEMARK OFFICE

Inventor:	Kazuo Sakagawa
Serial No.:	08/446,496
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Reissue of Patent No.:	5,774,662
Title:	SYSTEM FOR SERVER OBTAINING TERMINAL ADDRESS VIA SEARCHING ADDRESS TABLE OR VIA BROADCASTING TO ALL TERMINALS THROUGH ECHANGE IN RESPONSE TO TERMINAL ADDRESS INTERROGATION REQUEST
Issued:	June 30, 1998

Assistant Commissioner For Patents
Washington, D.C. 20231

REQUEST FOR TRANSFER OF DRAWINGS

S I R

Please transfer the drawing sheets 1-3, 5-12, 15-18, 20 and 22 from the original application, U.S. application serial no. 08/446,496 into the present Reissue application.

Any fee due with this paper, nor fully covered by an enclosed check, may be charged to Deposit account 08-1634. Figs. 5, 6, 15, 16 and 21 and 23 are being amended as

Any fee due with this paper, not fully covered by an enclosed check, may be charged on Deposit Acct. No. 08-1634

Filed by Express Mail
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by Linda S. Chen

indicated in the enclosed paper entitled Proposed Drawing Changes and once the Examiner approves these changes, new sheets 4, 13, 14, 19 and 21 will be submitted.

Respectfully submitted,

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SH/gau/16502

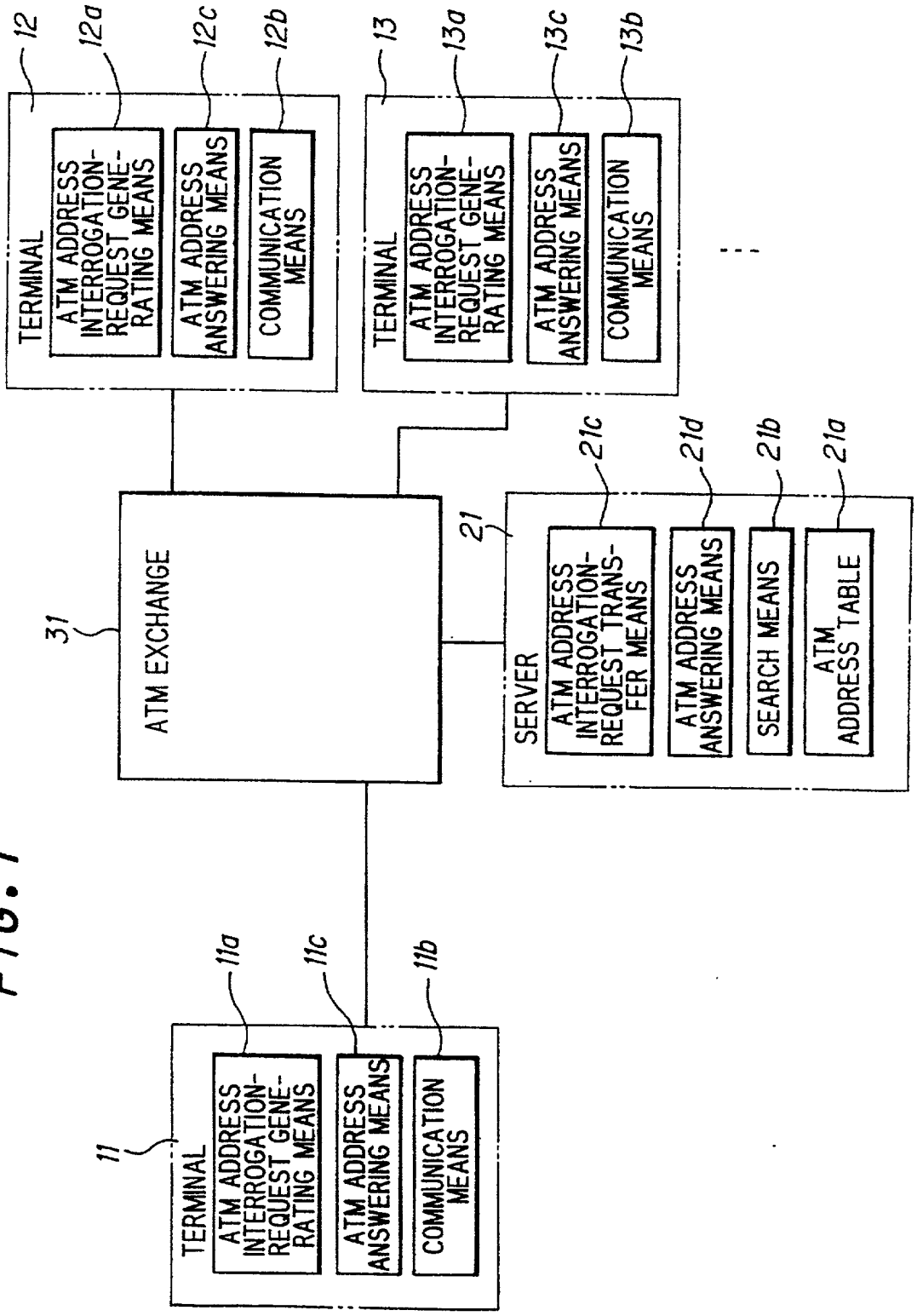

12
12a
12c
12b
TERMINAL
ATM ADDRESS INTERROGATION-REQUEST GENE-RATING MEANS
ATM ADDRESS ANSWERING MEANS
COMMUNICATION MEANS
13
13a
13c
13b
TERMINAL
ATM ADDRESS INTERROGATION-REQUEST GENE-RATING MEANS
ATM ADDRESS ANSWERING MEANS
COMMUNICATION MEANS
31
ATM EXCHANGE
21
21c
21d
21b
21a
SERVER
ATM ADDRESS INTERROGATION-REQUEST TRANS-FER MEANS
ATM ADDRESS ANSWERING MEANS
SEARCH MEANS
ATM ADDRESS TABLE
11
11a
11c
11b
TERMINAL
ATM ADDRESS INTERROGATION-REQUEST GENE-RATING MEANS
ATM ADDRESS ANSWERING MEANS
COMMUNICATION MEANS

FIG. 1

FIG. 2

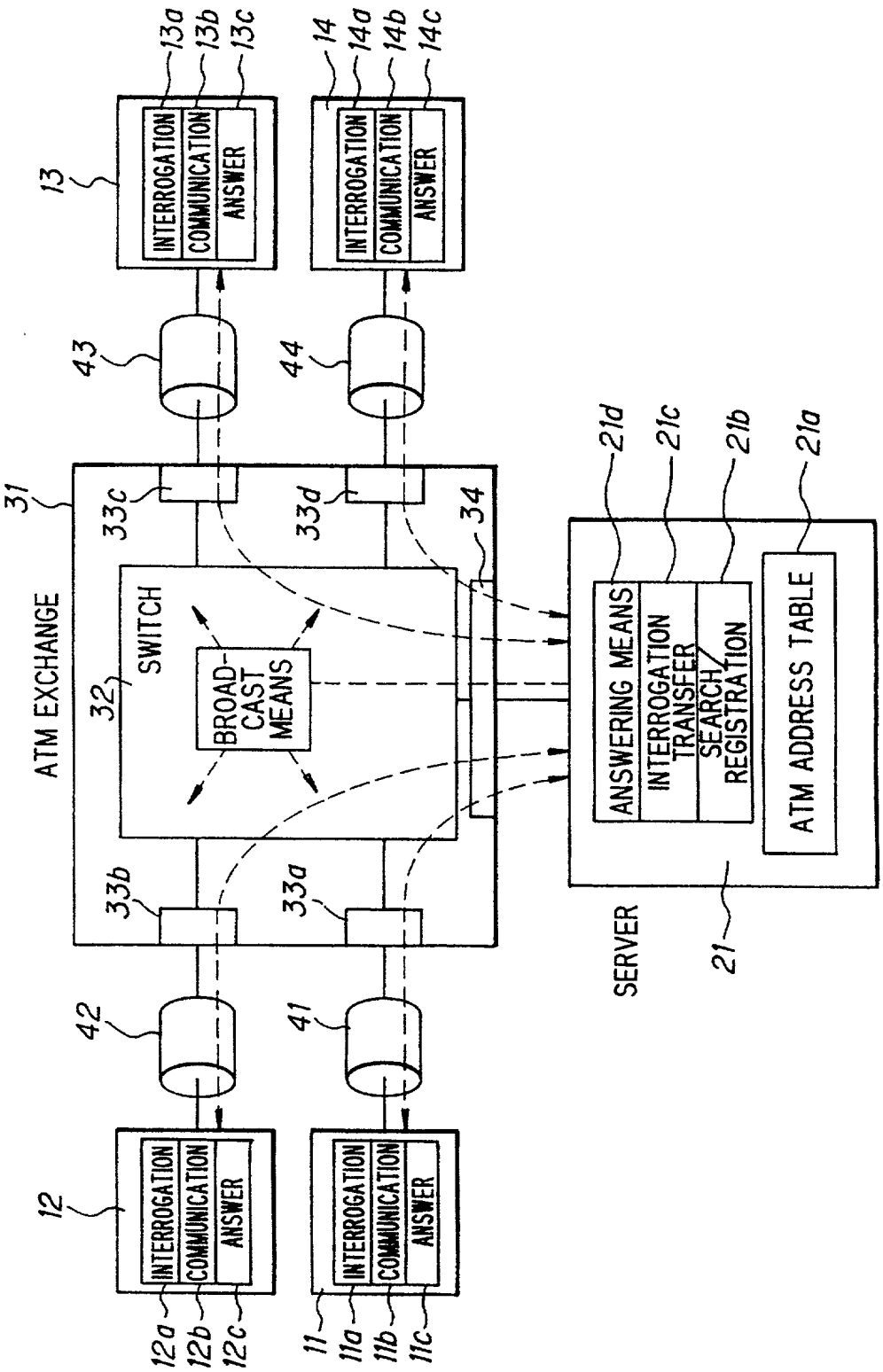

ATM EXCHANGE
31
SWITCH
32
BROAD-CAST MEANS
33a
33b
33c
33d
34
41
42
43
44
INTERROGATION
COMMUNICATION
ANSWER
11
11a
11b
11c
12
12a
12b
12c
13
13a
13b
13c
14
14a
14b
14c
SERVER
21
21a
21b
21c
21d
ANSWERING MEANS
INTERROGATION TRANSFER
SEARCH REGISTRATION
ATM ADDRESS TABLE

FIG. 3

PROTOCOL ADDRESS	ATM ADDRESS	REFERENCE TIME
B	b	12:16
A	a	09:11
C	c	16:22
D	d	08:20
⋮	⋮	⋮

FIG. 4A

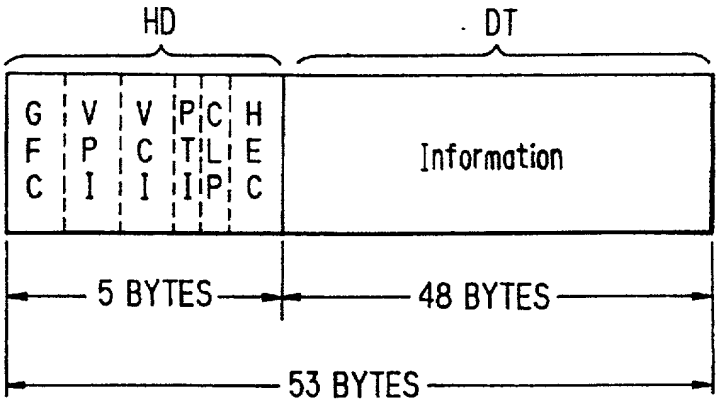


FIG. 4B

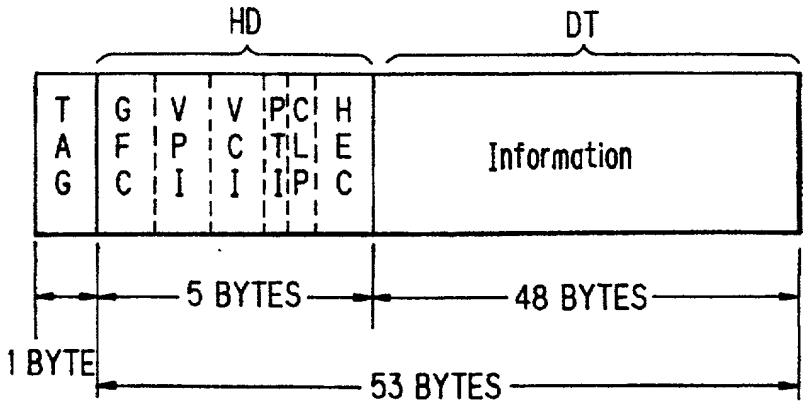


FIG. 7

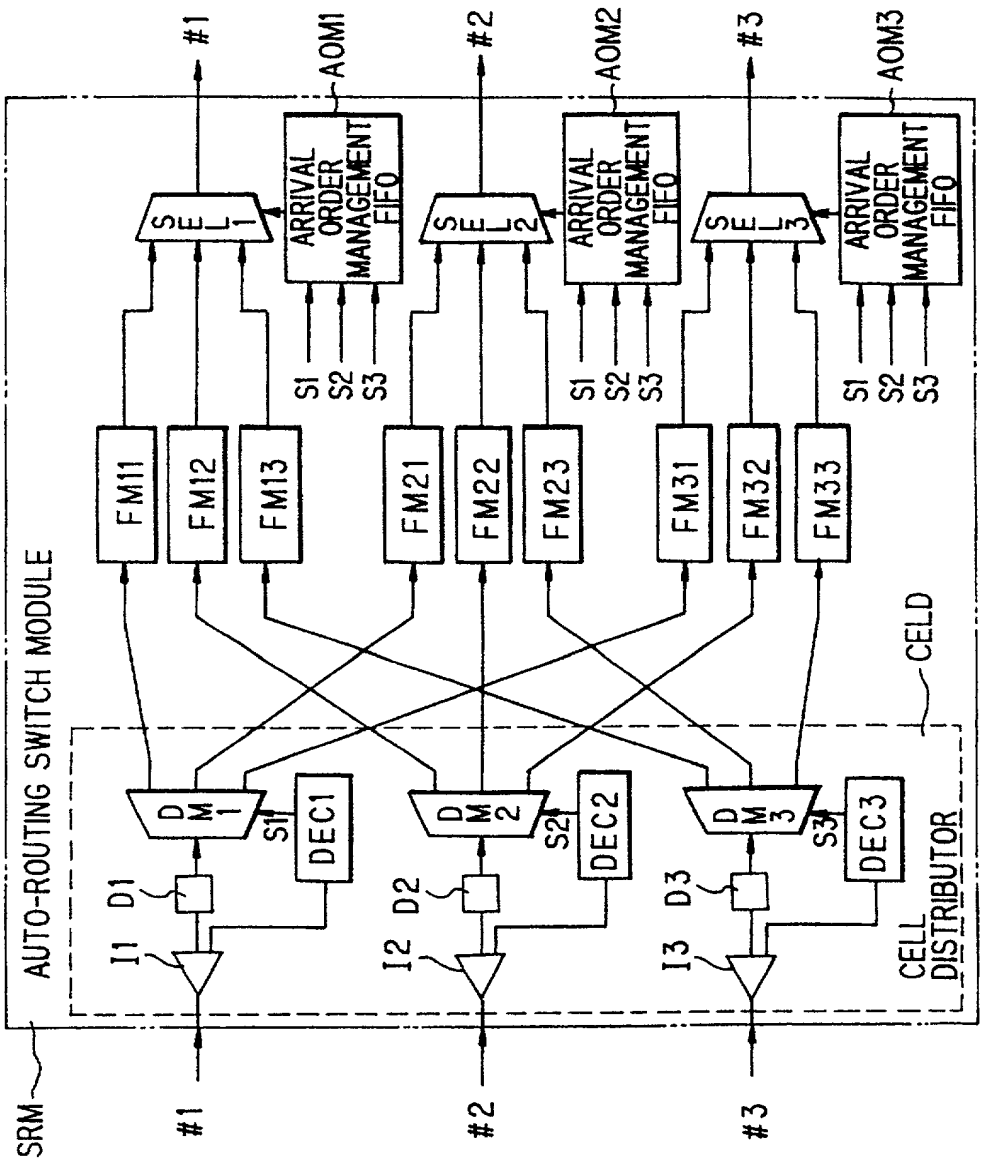

SRM
AUTO-ROUTING SWITCH MODULE
#1
#2
#3
AOM1
AOM2
AOM3
ARRIVAL ORDER MANAGEMENT FIFO
SEL1
SEL2
SEL3
S1
S2
S3
FM11
FM12
FM13
FM21
FM22
FM23
FM31
FM32
FM33
CELD
DM1
DM2
DM3
DEC1
DEC2
DEC3
D1
D2
D3
I1
I2
I3
CELL DISTRIBUTOR

FIG. 8

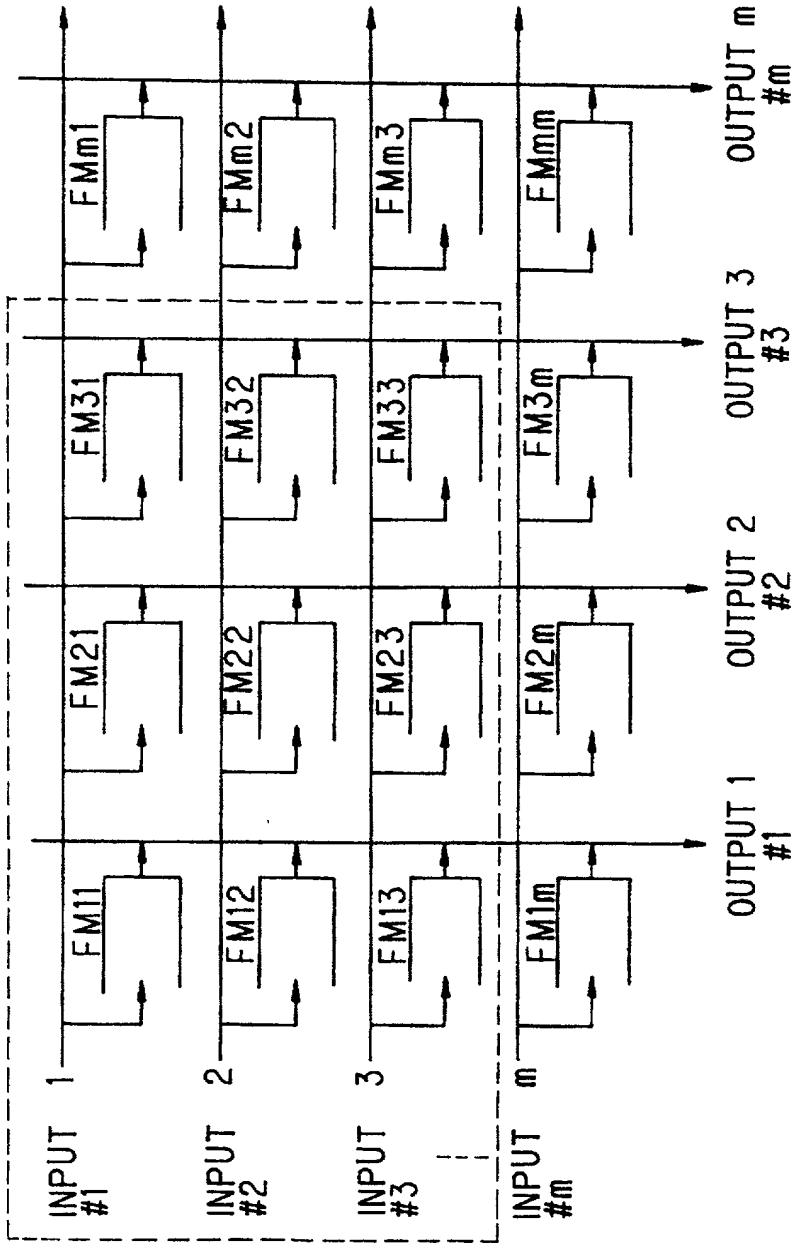

INPUT #1
INPUT #2
INPUT #3
INPUT #m
1
2
3
m
FM11
FM12
FM13
FM1m
FM21
FM22
FM23
FM2m
FM31
FM32
FM33
FM3m
FMm1
FMm2
FMm3
FMmm
OUTPUT 1 #1
OUTPUT 2 #2
OUTPUT 3 #3
OUTPUT m #m

FIG. 9

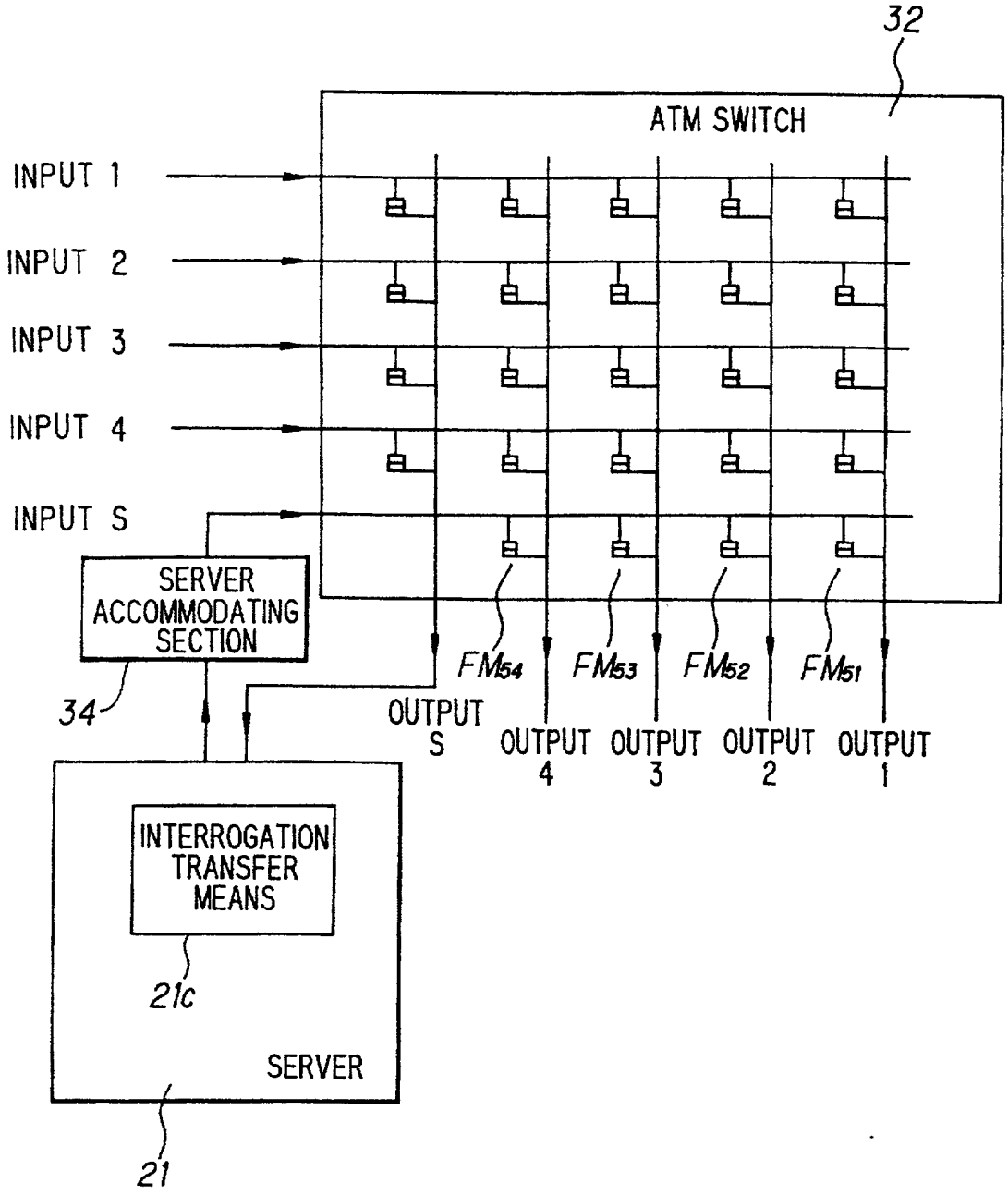

32
ATM SWITCH
INPUT 1
INPUT 2
INPUT 3
INPUT 4
INPUT S
SERVER ACCOMMODATING SECTION
34
FM54
FM53
FM52
FM51
OUTPUT S
OUTPUT 4
OUTPUT 3
OUTPUT 2
OUTPUT 1
INTERROGATION TRANSFER MEANS
21c
SERVER
21

FIG. 10

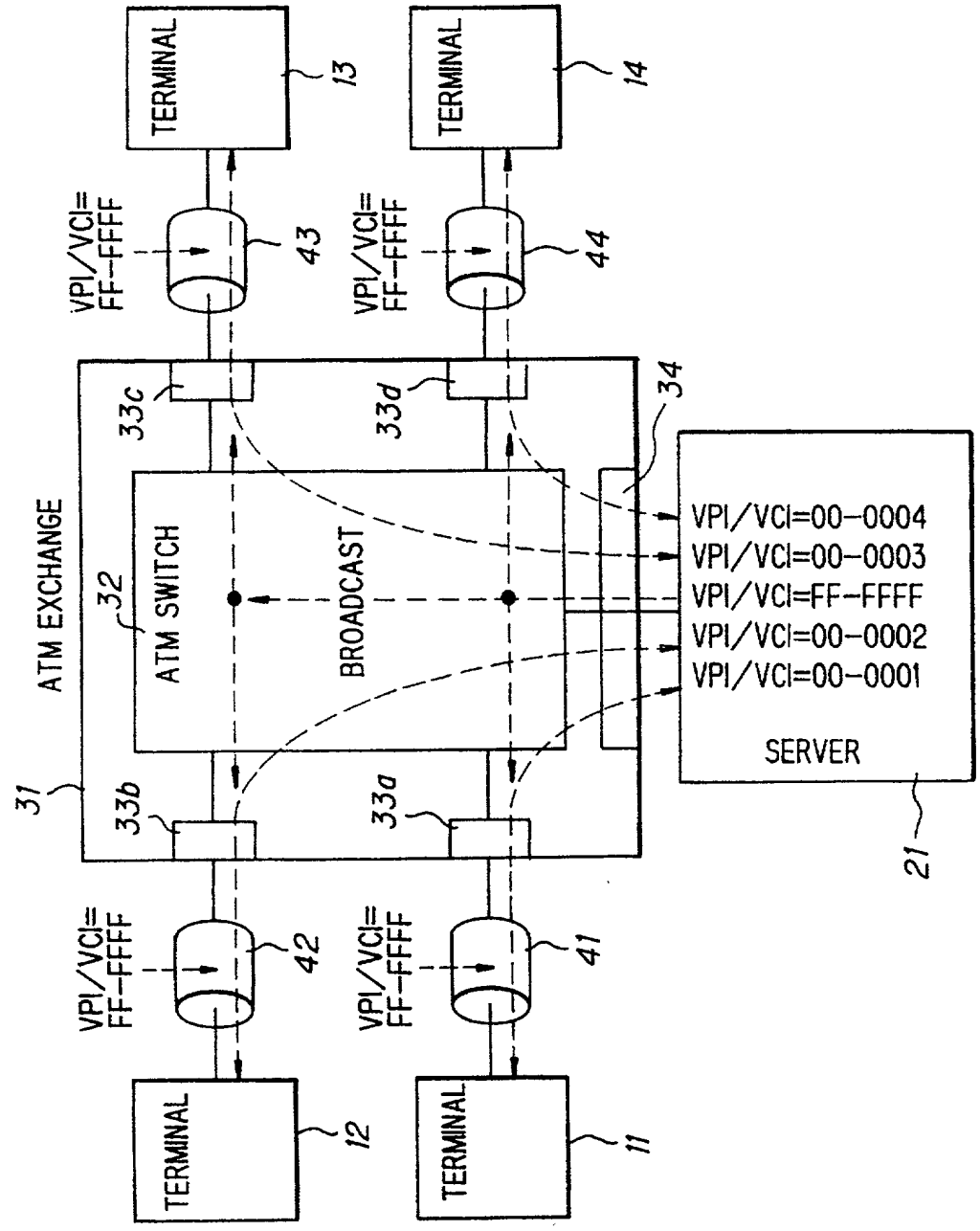

TERMINAL
13
TERMINAL
14
VPI/VCI=
FF-FFFF
43
VPI/VCI=
FF-FFFF
44
33c
33d
34
ATM EXCHANGE
31
ATM SWITCH
32
BROADCAST
VPI/VCI=00-0004
VPI/VCI=00-0003
VPI/VCI=FF-FFFF
VPI/VCI=00-0002
VPI/VCI=00-0001
SERVER
21
33b
33a
VPI/VCI=
FF-FFFF
42
VPI/VCI=
FF-FFFF
41
TERMINAL
12
TERMINAL
11

FIG. 11

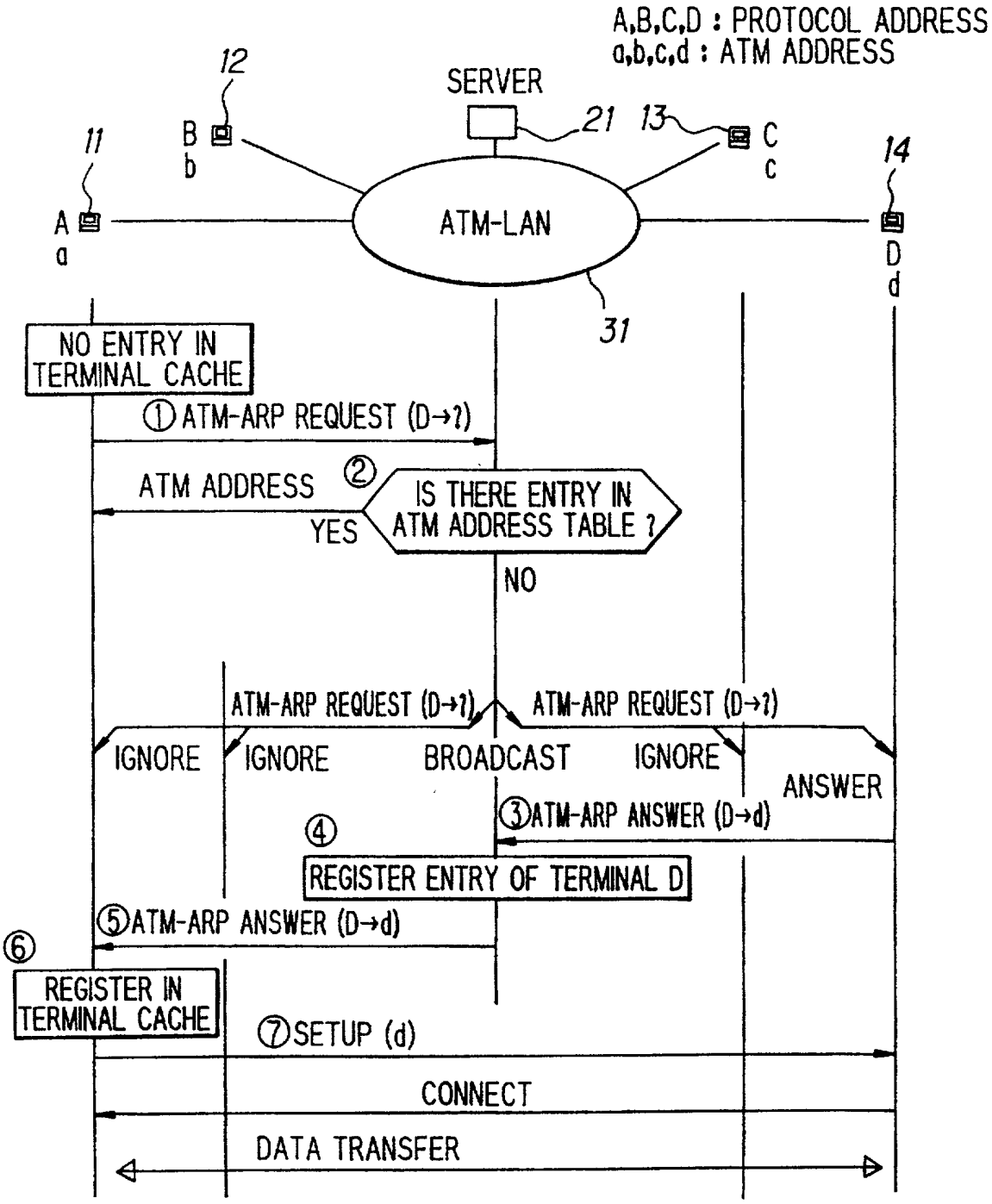

A,B,C,D : PROTOCOL ADDRESS
a,b,c,d : ATM ADDRESS
SERVER
12
21
13
11
14
B
b
C
c
A
a
ATM-LAN
D
d
31
NO ENTRY IN TERMINAL CACHE
① ATM-ARP REQUEST (D→?)
ATM ADDRESS
②
IS THERE ENTRY IN ATM ADDRESS TABLE ?
YES
NO
ATM-ARP REQUEST (D→?)
ATM-ARP REQUEST (D→?)
IGNORE
IGNORE
BROADCAST
IGNORE
ANSWER
③ ATM-ARP ANSWER (D→d)
④
REGISTER ENTRY OF TERMINAL D
⑤ ATM-ARP ANSWER (D→d)
⑥
REGISTER IN TERMINAL CACHE
⑦ SETUP (d)
CONNECT
DATA TRANSFER

FIG. 12

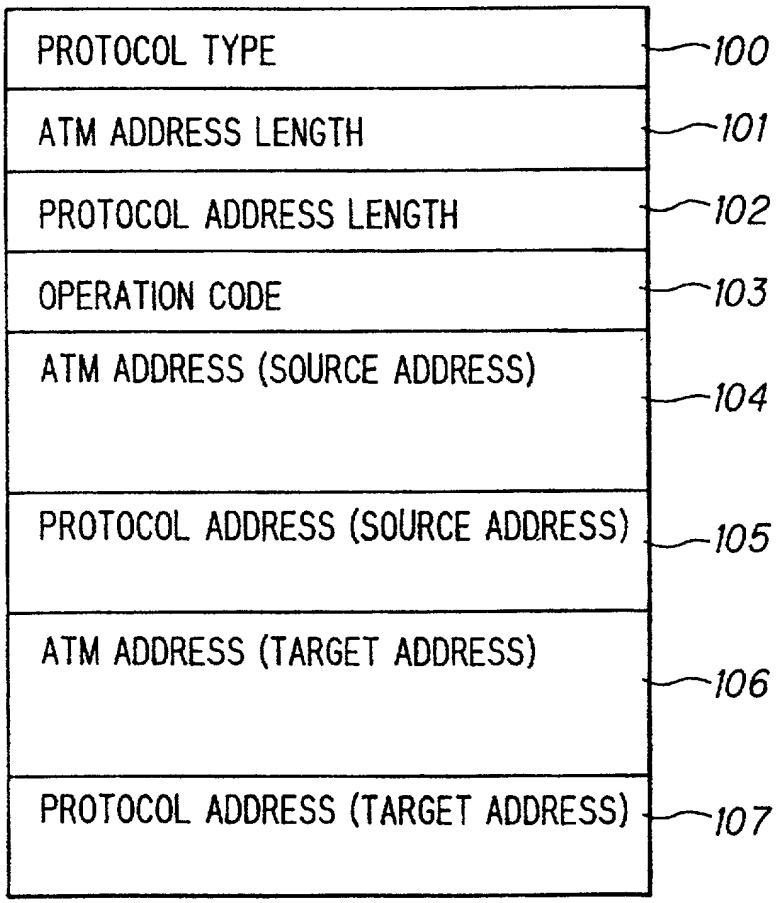

PROTOCOL TYPE
100
ATM ADDRESS LENGTH
101
PROTOCOL ADDRESS LENGTH
102
OPERATION CODE
103
ATM ADDRESS (SOURCE ADDRESS)
104
PROTOCOL ADDRESS (SOURCE ADDRESS)
105
ATM ADDRESS (TARGET ADDRESS)
106
PROTOCOL ADDRESS (TARGET ADDRESS)
107

FIG. 13

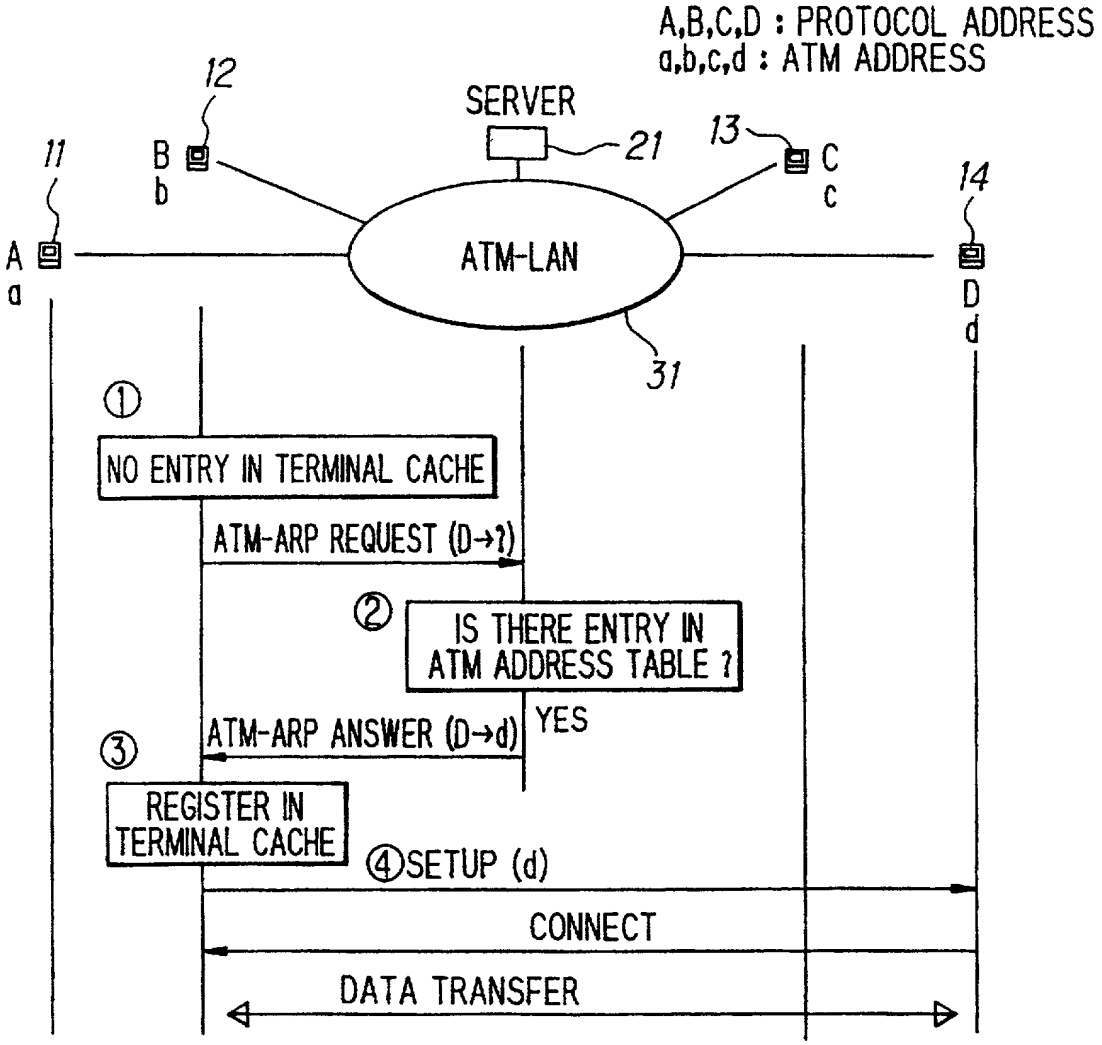

A,B,C,D : PROTOCOL ADDRESS
a,b,c,d : ATM ADDRESS
12
SERVER
21
13
11
B
b
C
c
14
A
a
ATM-LAN
D
d
31
①
NO ENTRY IN TERMINAL CACHE
ATM-ARP REQUEST (D→?)
②
IS THERE ENTRY IN ATM ADDRESS TABLE ?
YES
ATM-ARP ANSWER (D→d)
③
REGISTER IN TERMINAL CACHE
④SETUP (d)
CONNECT
DATA TRANSFER

FIG. 14

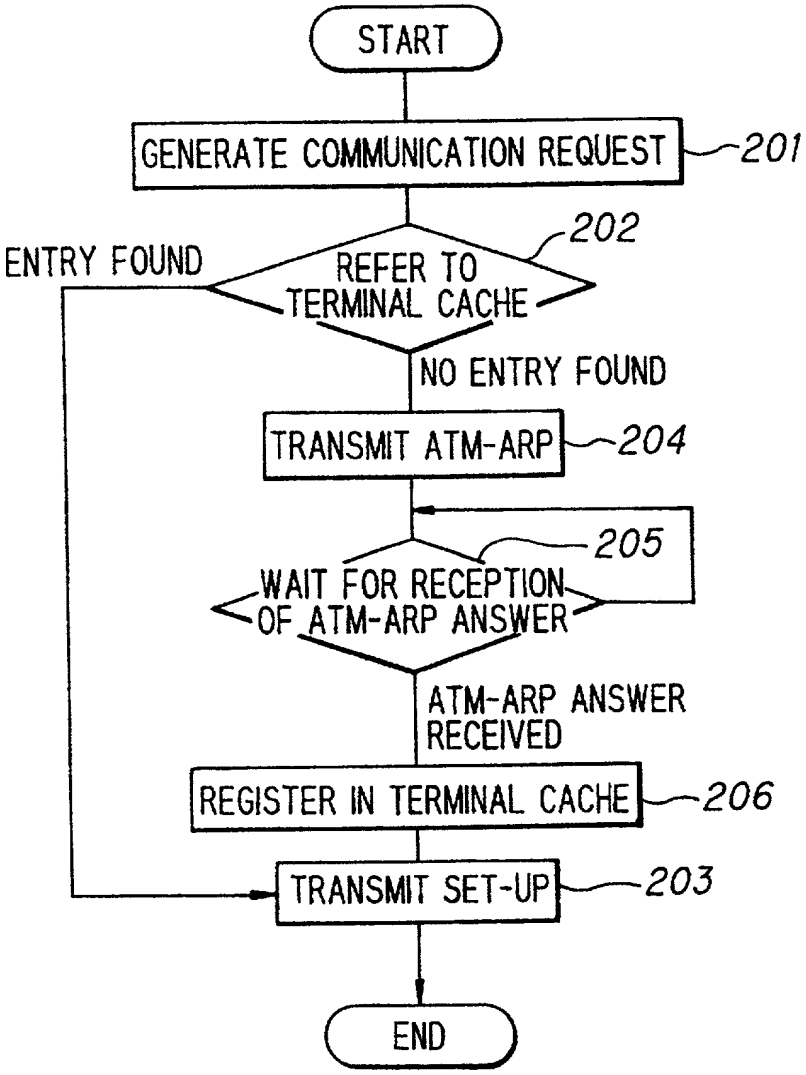

START
GENERATE COMMUNICATION REQUEST
201
202
ENTRY FOUND
REFER TO TERMINAL CACHE
NO ENTRY FOUND
TRANSMIT ATM-ARP
204
205
WAIT FOR RECEPTION OF ATM-ARP ANSWER
ATM-ARP ANSWER RECEIVED
REGISTER IN TERMINAL CACHE
206
TRANSMIT SET-UP
203
END

FIG. 17

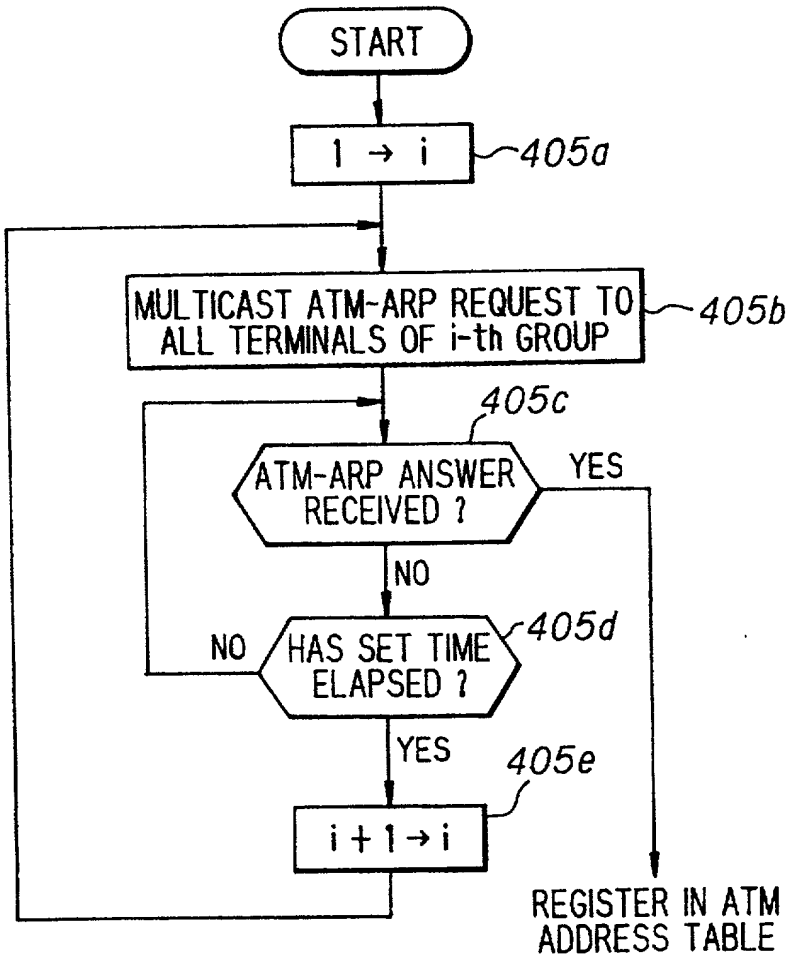

START
1 → i
405a
MULTICAST ATM-ARP REQUEST TO ALL TERMINALS OF i-th GROUP
405b
405c
ATM-ARP ANSWER RECEIVED ?
YES
NO
HAS SET TIME ELAPSED ?
405d
NO
YES
405e
i + 1 → i
REGISTER IN ATM ADDRESS TABLE

FIG. 18

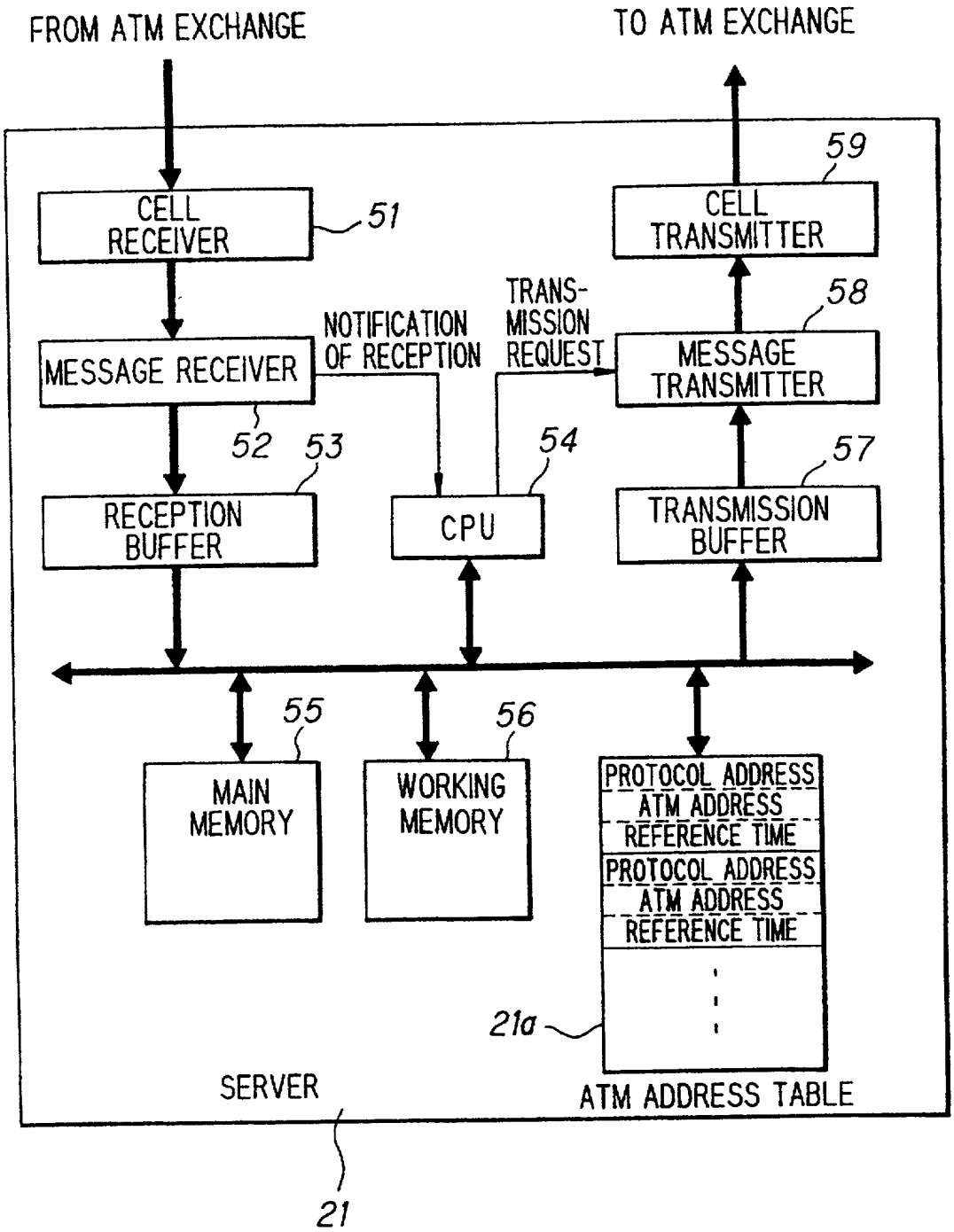

FROM ATM EXCHANGE
TO ATM EXCHANGE
CELL RECEIVER
51
CELL TRANSMITTER
59
MESSAGE RECEIVER
NOTIFICATION OF RECEPTION
TRANS-MISSION REQUEST
MESSAGE TRANSMITTER
58
52
53
54
57
RECEPTION BUFFER
CPU
TRANSMISSION BUFFER
55
56
MAIN MEMORY
WORKING MEMORY
PROTOCOL ADDRESS
ATM ADDRESS
REFERENCE TIME
PROTOCOL ADDRESS
ATM ADDRESS
REFERENCE TIME
21a
SERVER
ATM ADDRESS TABLE
21

FIG. 19

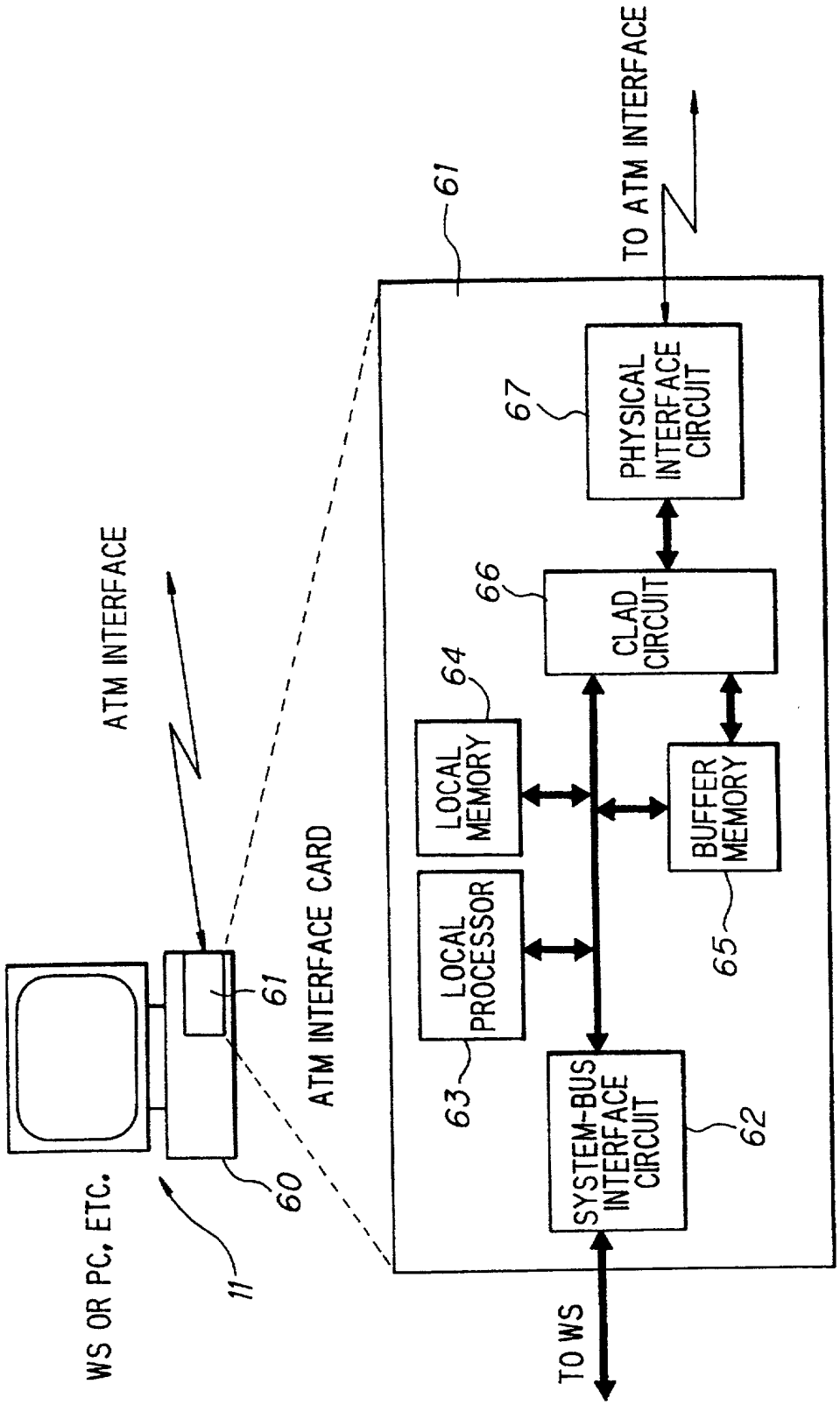

WS OR PC, ETC.
11
60
61
ATM INTERFACE CARD
ATM INTERFACE
TO WS
SYSTEM-BUS INTERFACE CIRCUIT
62
LOCAL PROCESSOR
63
LOCAL MEMORY
64
BUFFER MEMORY
65
CLAD CIRCUIT
66
PHYSICAL INTERFACE CIRCUIT
67
TO ATM INTERFACE
61

FIG.20

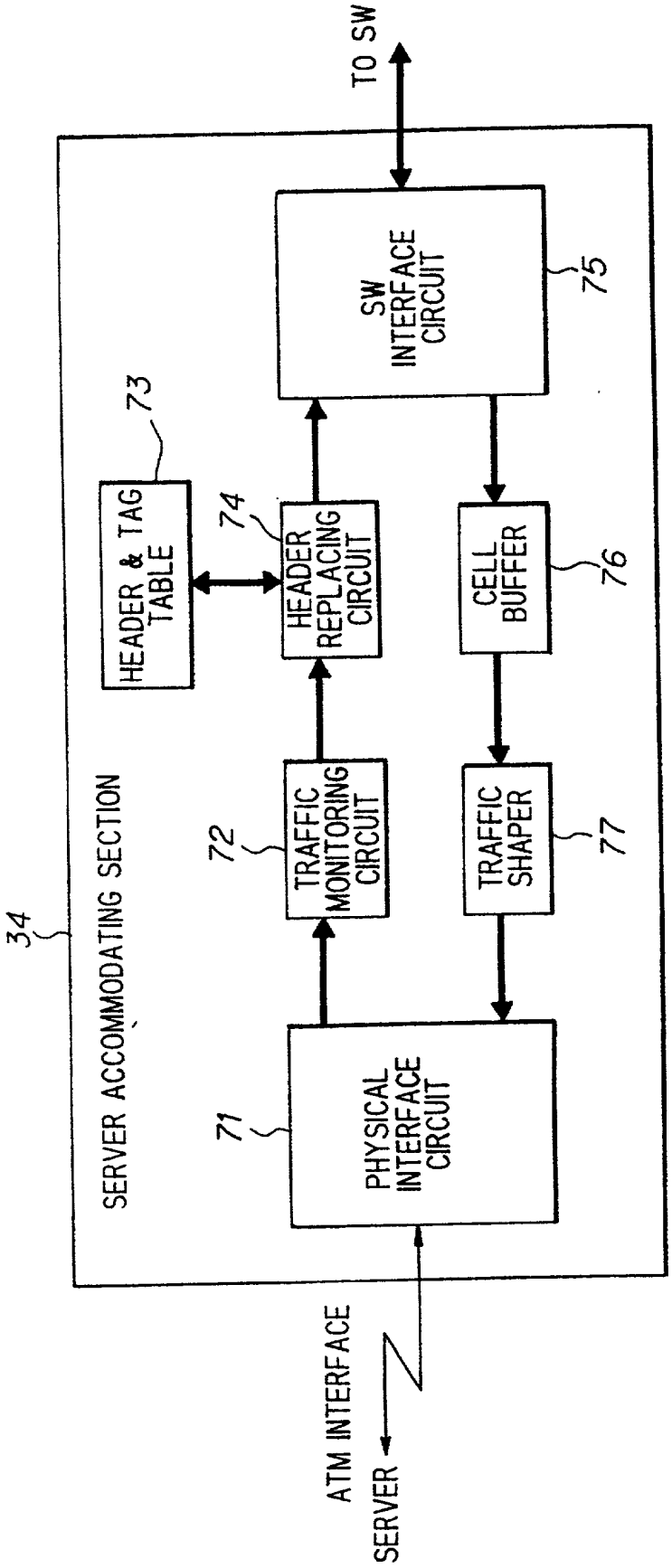

TO SW
SW INTERFACE CIRCUIT
75
73
HEADER & TAG TABLE
74
HEADER REPLACING CIRCUIT
CELL BUFFER
76
72
TRAFFIC MONITORING CIRCUIT
TRAFFIC SHAPER
77
34
SERVER ACCOMMODATING SECTION
71
PHYSICAL INTERFACE CIRCUIT
ATM INTERFACE
SERVER

FIG. 22 (PRIOR ART)

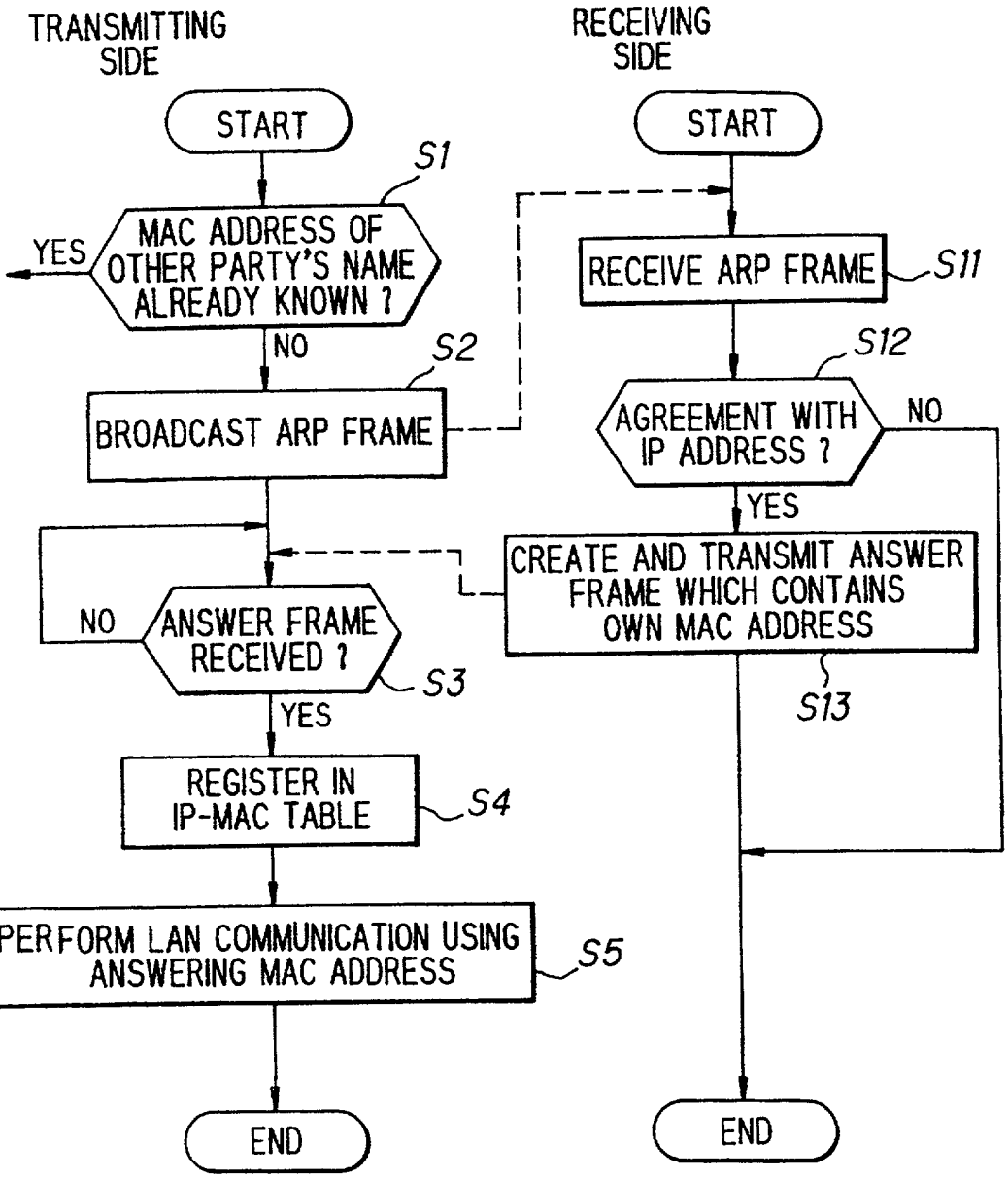
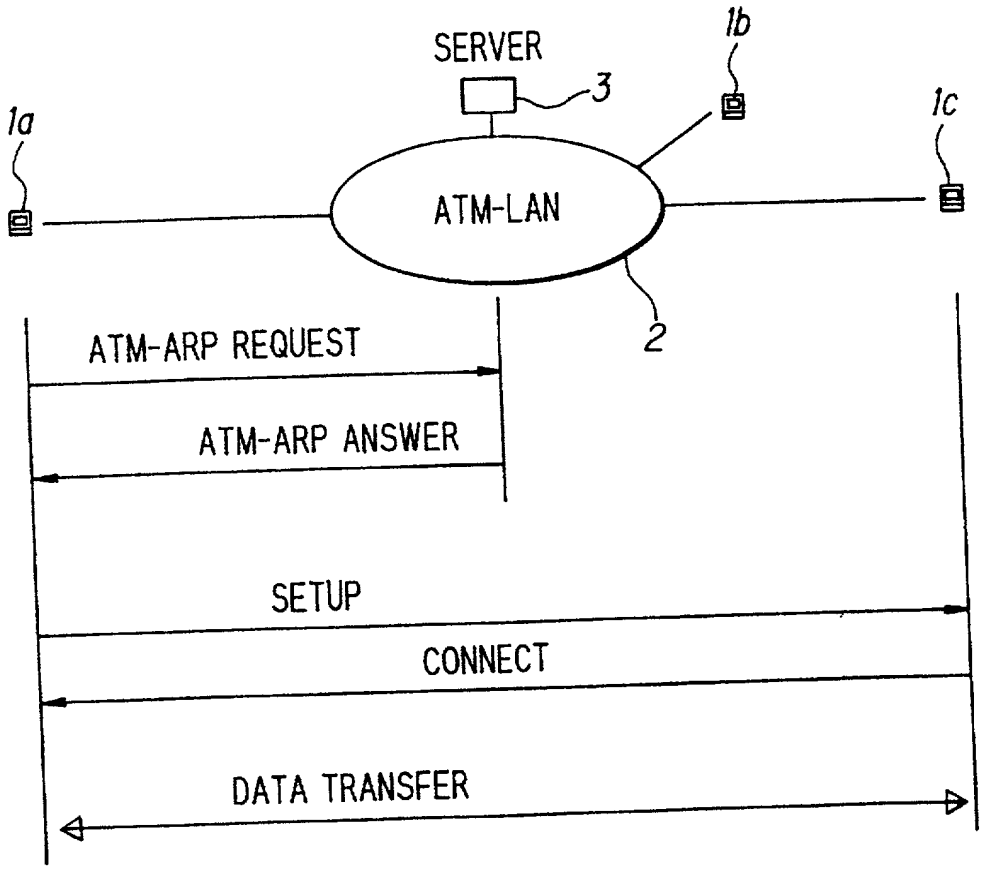


FIG.24 (PRIOR ART)



IN THE UNITED PATENT AND TRADEMARK OFFICE

Inventor:	Kazuo Sakagawa
Serial No.:	08/446,496
Filed:	May 22, 1995
Reissue of Patent No.:	5,774,662
Title:	SYSTEM FOR SERVER OBTAINING TERMINAL ADDRESS VIA SEARCHING ADDRESS TABLE OR VIA BROADCASTING TO ALL TERMINALS THROUGH ECHANGE IN RESPONSE TO TERMINAL ADDRESS INTERROGATION REQUEST
Issued:	June 30, 1998

Assistant Commissioner For Patents
Washington, D.C. 20231

REQUEST FOR DRAWING CHANGES

SIR:

Enclosed are copies of proposed drawing changes to Figures 5, 6, 15, 16, 21 and 23. The changes are shown in red. Kindly approve such changes and substitute sheets will be submitted.

Respectfully submitted,

Any fee due with this paper, not fully covered by an enclosed check, may be charged on Deposit Acct. No. 08-1634

Samson Helfgott
Reg. No. 23,072
Attorney for Applicants

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New York, New York 10118
(212) 643-5000
Docket No: FUJA 12.689A
SH/mau/16527

Filed by Express Mail
(Receipt No. EM367156855US
on October 26, 1998
pursuant to 37 C.F.R.1.10
by

FIG. 5

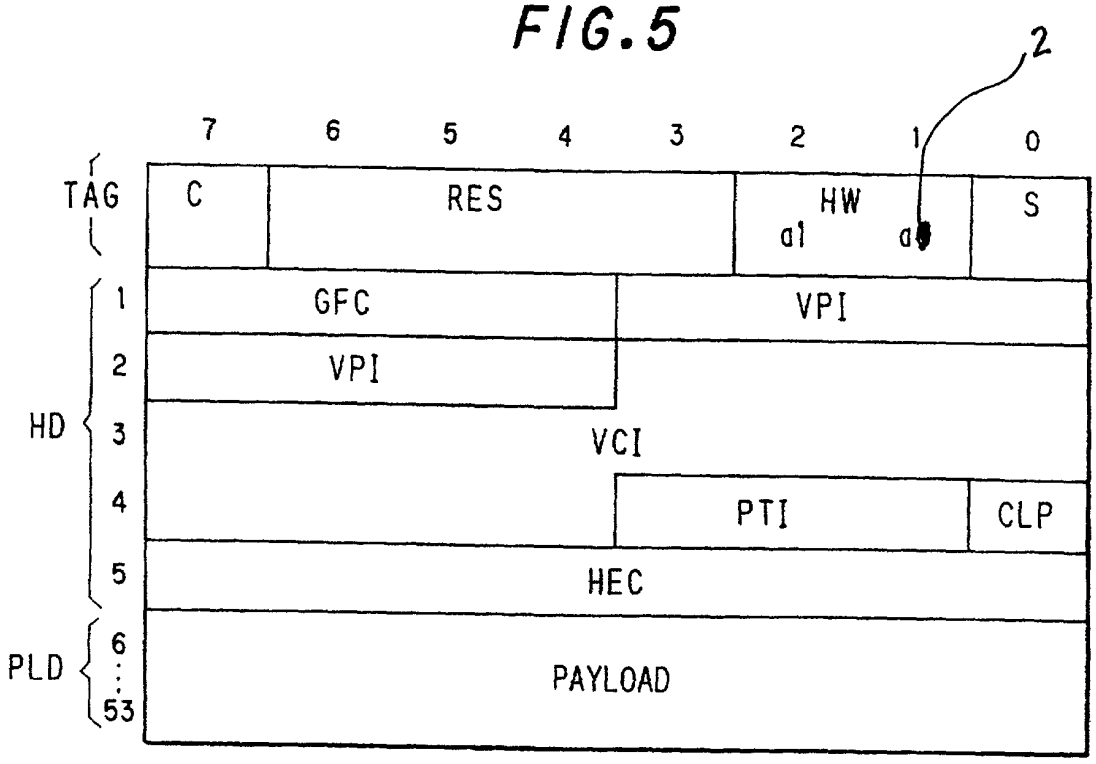


FIG. 6

TAG INFORMATION				SELECTED OUTPUT				
C	a1	a0	S	OUTPUT 1	OUTPUT 2	OUTPUT 3	OUTPUT 4	OUTPUT S
0	0	0	0	●	—	—	—	—
0	0	1	0	—	●	—	—	—
0	1	0	0	—	—	●	—	—
0	1	1	0	—	—	—	●	—
0	x	x	1	—	—	—	—	●
1	x	x	0	●	●	●	●	—

FIG. 15

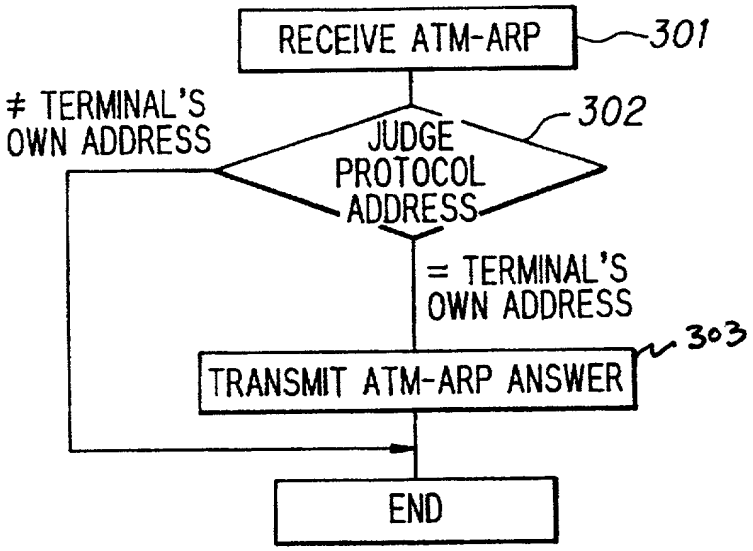

RECEIVE ATM-ARP
301
≠ TERMINAL'S OWN ADDRESS
JUDGE PROTOCOL ADDRESS
302
= TERMINAL'S OWN ADDRESS
TRANSMIT ATM-ARP ANSWER
303
END

FIG. 16

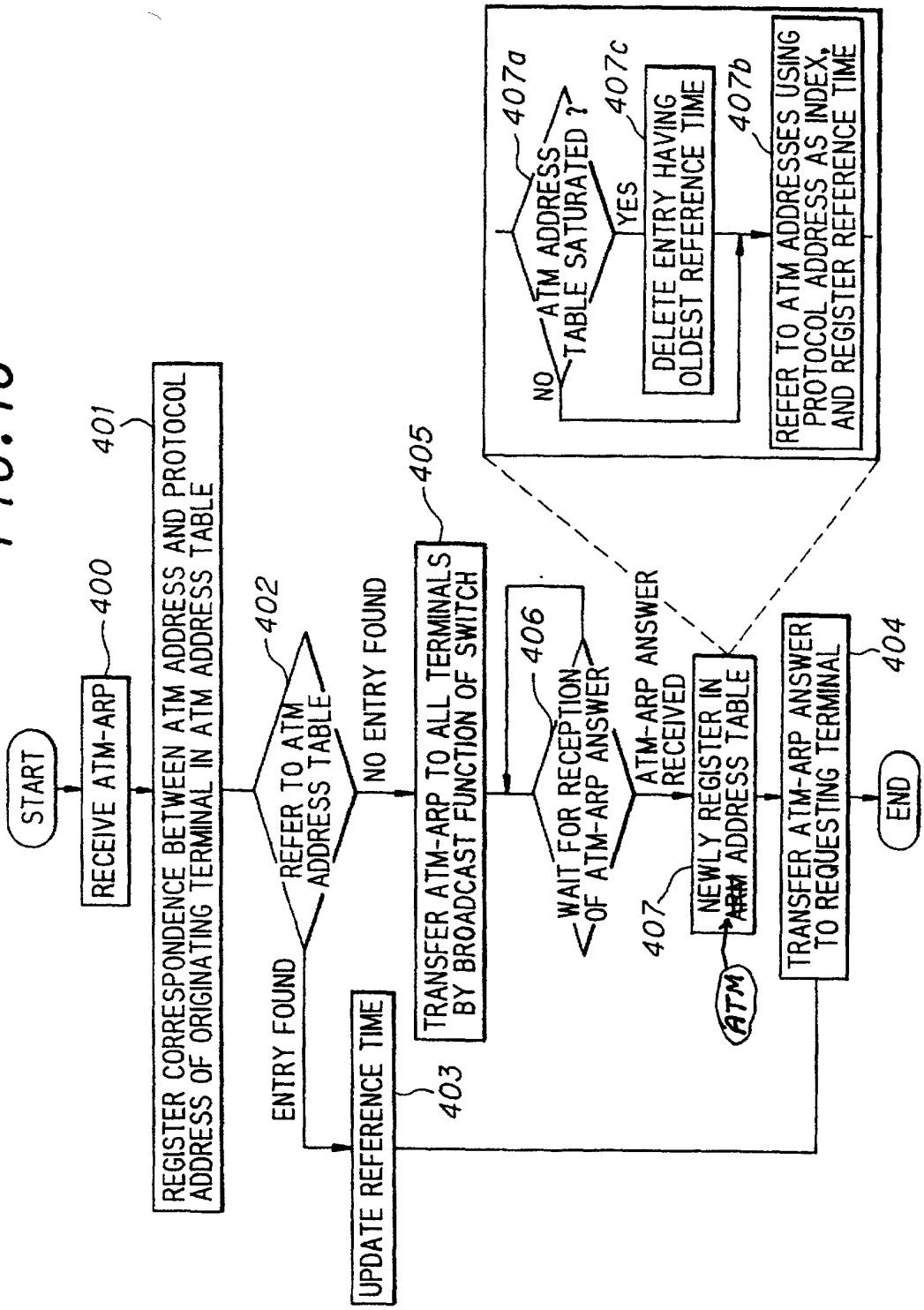

START
400
RECEIVE ATM-ARP
401
REGISTER CORRESPONDENCE BETWEEN ATM ADDRESS AND PROTOCOL ADDRESS OF ORIGINATING TERMINAL IN ATM ADDRESS TABLE
402
REFER TO ATM ADDRESS TABLE
ENTRY FOUND
NO ENTRY FOUND
403
UPDATE REFERENCE TIME
405
TRANSFER ATM-ARP TO ALL TERMINALS BY BROADCAST FUNCTION OF SWITCH
406
WAIT FOR RECEPTION OF ATM-ARP ANSWER
ATM-ARP ANSWER RECEIVED
407
NEWLY REGISTER IN ATM ADDRESS TABLE
ATM
404
TRANSFER ATM-ARP ANSWER TO REQUESTING TERMINAL
END
407a
ATM ADDRESS TABLE SATURATED ?
NO
YES
407c
DELETE ENTRY HAVING OLDEST REFERENCE TIME
407b
REFER TO ATM ADDRESSES USING PROTOCOL ADDRESS AS INDEX, AND REGISTER REFERENCE TIME

FIG. 21

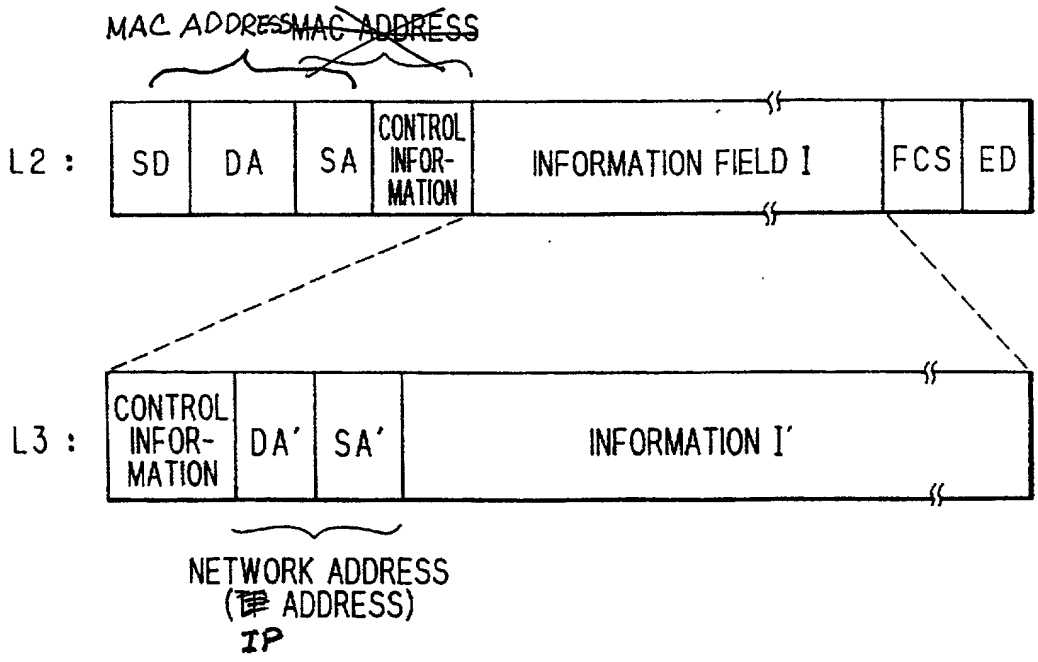
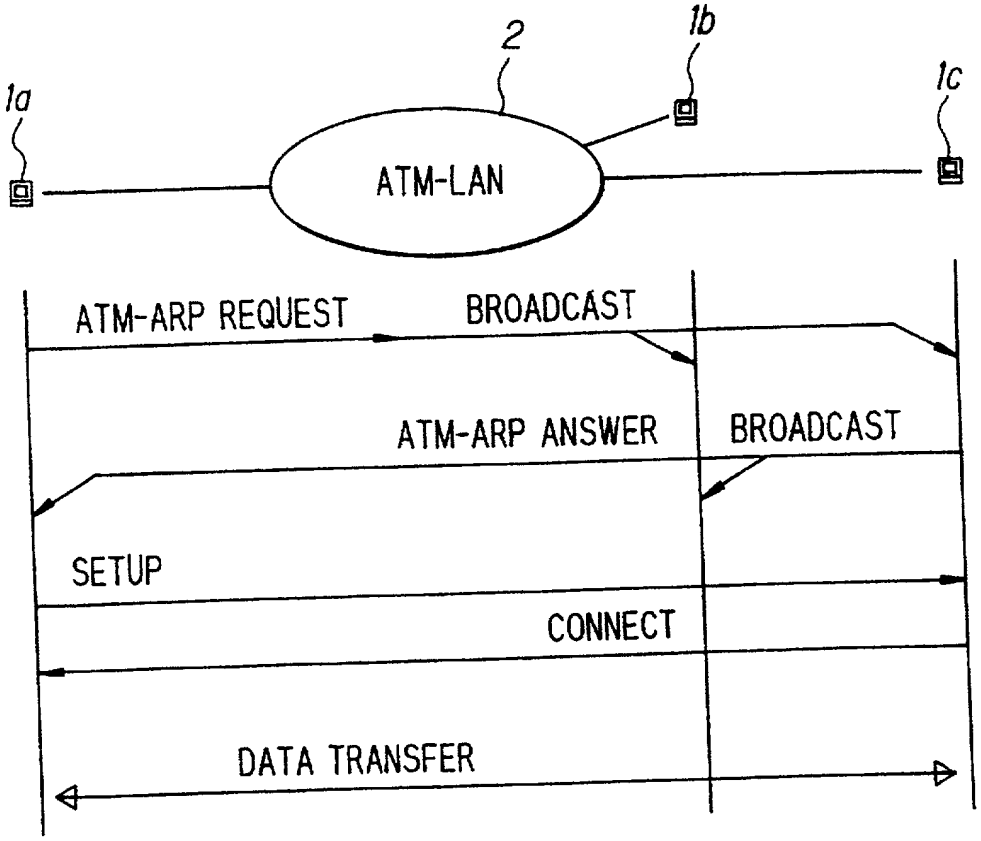

MAC ADDRESS
L2 :
SD
DA
SA
CONTROL INFOR-MATION
INFORMATION FIELD I
FCS
ED
L3 :
CONTROL INFOR-MATION
DA'
SA'
INFORMATION I'
NETWORK ADDRESS
(IP ADDRESS)
IP

FIG. 23 ~~(PRIOR ART)~~



IN THE UNITED PATENT AND TRADEMARK OFFICE

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Issued:	June 30, 1998

Assistant Commissioner For Patents
Washington, D.C. 20231

DECLARATION OF INVENTOR

S I R

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are stated below next to my name.

I believe that I am an original and first inventor of the subject matter which is described and claimed in U.S. Patent No. 5,774,662 granted June 30, 1998, and for which a reissue patent is sought on the invention entitled "SYSTEM FOR SERVER OBTAINING TERMINAL VIA SEARCHING ADDRESS TABLE OR VIA BROADCASTING TO ALL TERMINALS THROUGH EXCHANGE IN RESPONSE

Any fee due with this paper, not fully covered by an enclosed check, may be charged on Deposit Acct. No. 08-1634

Filed by Express Mail
(Receipt No. EM367156855US
on October 26, 1999
pursuant to 37 C.F.R. 1.10
by Linda S. Chan

TO TERMINAL ADDRESS INTERROGATION REQUEST," the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment which may have been included herewith.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code §119 of JP 6-153381, filed July 5, 1994 in Japan. I claim further that there are no other foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

I declare that I believe the original patent to be wholly or partly inoperative by reason of claiming less than the patentee had the right to claim. In particular, that the particular technology contained in Figure 23 was not known or reduced to practice by others prior to the priority date of this application, but were in fact my own ideas and accordingly, an error was made in describing adequate prior art due to my not being familiar with the meaning of prior art and the U.S. Practice. This resulted in my not claiming all of the invention that I was entitled to.

Further, I noticed other minor errors in the drawings and the text related to proper description of the figures .

In view of the above error, corrections are being made to the specifications and drawings and new claims are being submitted. Further, I declare that the above error arose without deceptive intent.

I further declare that all statements made herein of my knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section1001 of Title 19 of the United States Code, and that such false statements may jeopardize the validity of any patent issuing thereon.

Full name of inventor: Kazuo SAKAGAWA
Inventor's signature: Kazuo Sakagawa
Residence: Nagoya-shi, Aichi, Japan
Post Office Address: Omotedai 138-203, Tenpaku-ku,
Nagoya-shi, 468-0068 Japan
Citizenship: Japan

SH/gau/16497